APPENDIX "A"

In the
United States Court of Appeals
For the Seventh Circuit

No. 75-1100

CTS CORPORATION,

Plaintiff-Appellee,

v.

PIHER INTERNATIONAL CORPORATION and PIHER SOCIEDAD ANONIMA,

Defendants-Appellants.

Appeal from the United States District Court for the Northern District of Illinois, Eastern Division
No. 72 C 1891
JULIUS J. HOFFMAN, *Judge*

ARGUED JUNE 11, 1975 — DECIDED DECEMBER 17, 1975

Before CLARK, *Associate Justice (Retired)**, STEVENS, *Circuit Judge*, and GRANT, *Senior District Judge.***

STEVENS, *Circuit Judge.* Appellants contend that the district court erroneously rejected their attacks on the validity of the '604[1] and '285[2] patents on variable resistance

* Associate Justice Tom C. Clark of the Supreme Court of the United States (Retired) is sitting by designation.

** Senior District Judge Robert A. Grant of the Northern District of Indiana is sitting by designation.

[1] Patent No. 3,518,604 on "Electrical Component" issued to appellee as assignee of Beaver and Van Benthuysen on June 30, 1970, pursuant to application filed February 12, 1968.

[2] Patent No. 3,670,285 on "Variable Resistance Control With End Collector" issued to appellee as assignee of English on June 13, 1972, pursuant to application filed March 16, 1970.

controls and erroneously found that their "PT-15" trimmer infringed the former patent. The '604 patent discloses a flared bearing used as a dust excluding seal of an aperture in the housing enclosing the control. The '285 patent describes a mechanical assembly which uses a metallic collector—an essential component of the control—as the base of the housing.

The principal issues on appeal are (1) whether one of appellee's earlier patents ('478)[3], which disclosed the use of a flared bearing to hold the components of the control together, made the '604 improvement obvious; (2) whether the failure to cite '478 to the Patent Office during the processing of the '604 application breached appellee's duty of disclosure; (3) whether reversal of the finding that the '604 patent has been infringed is required by either (a) the fact that appellants' PT-15 trimmer (which apparently is similar to appellee's '285 device) uses a metallic collector as a base, whereas the device described in the '604 specifications uses a nonconductor and admittedly would not function with a metal base, or (b) the fact that the PT-15 trimmer uses a flared bearing to seal only one of two openings in its housing; (4) whether the erroneous exclusion of critical evidence frustrated the presentation of a meritorious "on sale" challenge to the valid- of the '285 patent;[4] and (5) whether appellee's development of the '285 device was so abortive that either (a) it was not "useful" within the meaning of § 101;[5] or (b) the patent specifications failed to describe "the best mode" of carrying out the invention as required by § 112;[6] or

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[3] Patent No. 3,375,478 on "Electrical Control And Method of Making the Same" issued to appellee as assignee of Van Benthuysen and Barden on March 26, 1968, pursuant to application filed May 11, 1964.

[4] 35 U.S.C. § 102(b) provides that a person shall be entitled to a patent unless the invention was ". . . on sale in this country, more than one year prior to the date of the application for patent in the United States. . . ."

[5] 35 U.S.C. § 101 provides that one who "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

[6] 35 U.S.C. § 112 provides, in part:

"The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is

(c) the invention was "abandoned" within the meaning of § 102(c).[7] We shall briefly describe the product, the parties, and the posture of the case, and then discuss the facts in greater detail in connection with our consideration of the several issues.

A variable resistor—sometimes called a "potentiometer" or a "trimmer"—is used to adjust the electrical resistance of an electronic circuit to a desired level. The volume and tone controls on a television or radio set are examples of variable resistors. The essential elements of such a control include (1) a *driver,* or shaft, which may be turned manually or with a tool, such as a screwdriver; (2) a *contactor,* which is affixed to, and may be rotated by, the driver, and which makes electrical contact between the collector and the resistance element; (3) the *collector,* which must be a conductor of electrical current and is installed in a fixed position; and (4) the *resistance element,* which may be a horseshoe shaped sliver of carbon affording varying degrees of electrical resistance, depending upon the location of the contactor which may be swept from one end of the resistance element to the other by turning the driver. These elements may be arranged in a variety of configurations and sizes; in some designs they are enclosed within a dust excluding housing. The patents in suit relate to the mechanical structure rather than the electrical technology of the controls.

The parties are competitors in the manufacture and sale of electrical components for television sets. The appellants are a Spanish manufacturing corporation[8] and its affiliated American distributor,[9] which the district court found to be the "alter ego" of its parent. Since that finding is not challenged, we shall refer to the two simply as "Piher."

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[6] (Continued)

most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention."

[7] 35 U.S.C. § 102(c) provides that a person shall be entitled to a patent unless "he has abandoned the invention, ..."

[8] Piher Sociedad Anonima.

[9] Piher International Corporation, an Illinois corporation with offices in Park Ridge, Illinois.

Appellee ("CTS"), an Indiana corporation,[10] originally accused Piher of infringing four of its patents.[11] Since one of these has now expired, and since only minimal damages are recoverable as a result of infringement of the second, Piher has not appealed from the holding that those two patents were valid and infringed. Moreover, by stipulation the parties withdrew the question whether Piher's PT-15 trimmer infringes the '285 patent, as well as the question of priority of invention of what we infer to be essentially the same disclosure in the CTS '285 patent and in Piher's Spanish patent describing the PT-15 trimmer; that priority issue is the subject of an interference proceeding pending in the Patent Office. Specific attacks on the validity of the '285 patent were, however, raised by Piher's counterclaim and decided by the district court. The issues on appeal, therefore, involve the validity of '604 and '285 and infringement of '604. We turn to those issues.

I.

The specifications in the '604 patent describe a variable resistor which is completely enclosed in a tiny boxlike plastic housing containing one round opening through which a plastic driver or shaft projects. That projection of the shaft is in the form of a barrel which includes a flared bearing extending outwardly from the periphery of the opening. The bearing fits against the surface of the housing with sufficient firmness to hold the components of the device securely together and yet be smoothly rotatable; it also performs the function of preventing dust or other foreign matter from entering the component.

Piher argues that the '604 improvement was obvious because (a) with one exception, the general arrangement of its components within a dust excluding housing was disclosed by Barden-'140,[12] and (b) that one exception, namely the flared bearing, was disclosed by appellee's

[10] CTS Corporation has its principal place of business in Elkhart, Indiana.

[11] The '604, '285, and '478 patents identified in notes 1, 2, and 3, and an earlier patent, No. 2,740,027, which has since expired.

[12] Patent No. 3,237,140 on "Variable Resistance Control" issued on Febuary 22, 1966, to CTS as assignee of Barden and Snyder pursuant to application filed on May 20, 1963.

'478 patent. We agree with Piher's premises but not with its conclusion.

In Barden-'140 the sealing function was performed by a thrust washer encircling the driver just inside the opening in the housing. Both the '478 patent and the '604 patent describe unsatisfactory characteristics of such a washer and disclose a construction which substitutes a flared bearing—i.e., an enlargement of a portion of the driver—for the washer. That substitution having been disclosed by '478, Piher argues that the same substitution disclosed in '604 must surely be classified as obvious.

If the flared bearing in '604 merely performed the function of maintaining a secure relationship among the components during adjustment, Piher's argument would be valid. But in '604 the flared bearing is designed to perform the additional dust excluding function, a function not even arguably performed by its antecedent in '478.[13] Indeed, since the '478 device is not enclosed in a housing, that patent does not concern itself with the use of any sealing member, and therefore neither implicitly nor explicity suggests that the enlarged portion of the shaft may be used to perform a sealing function.

Although each of the elements of the '604 combination was disclosed by either Barden-'140 or by the '478 patent, the fact that the flared bearing would successfully perform a sealing function was disclosed by neither. According to expert testimony which the trial judge credited, that fact was not obvious to persons skilled in the art when the invention was made. Since the sealing function of the bearing in the '604 device was of critical importance in the Examiner's decision to allow the claims,[14] and since his

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[13] In '478 what we refer to as a "flared bearing" is actually described as an "enlarged portion" of the shaft. (See column 4, lines 34-38; it is element 31c in Figs. 1 and 3.)

[14] Claim 1 of '604, which reads as follows was allowed only after an amendment which added the italicized language:

"1. A variable resistance control comprising a dust excluding housing having a plurality of walls, *a base closing the housing and forming a wall thereof*, an aperture in one of the walls, a driver supported by the housing for rotation relative thereto, resistance means supported within the housing, *and* a contactor wipingly engaging the resistance means and constrained to rotate with the driver, the driver comprising a body portion and a barrel integral with the body portion, the barrel extending through the aperture

decision is presumptively correct, the nonobviousness of that application of a flared bearing in a variable resistance control justifies the district court's conclusion that the concept was patentable.

II.

As we have already pointed out, the flared bearing in '604 performed both a structural function and a sealing function. If only the former were involved, CTS clearly would have been obligated to call the Patent Examiner's attention to '478. Indeed, in view of the discussion of the structural importance of the flared bearing in '604, we are somewhat surprised and troubled by the failure even to cite '478 during the prosecution of the '604 application. Nevertheless, we accept appellee's argument that since '478 described a component which was not enclosed in a housing, and therefore had no relevance to the function of sealing an opening in a housing, prior art which disclosed the use of comparable closures to seal openings in other enclosed devices was more pertinent than '478.[15]

That conclusion does not necessarily lead to the further conclusion that the failure to cite '478 did not violate the applicant's duty of disclosure. We must assume that the applicant deliberately decided not to call the Examiner's attention to '478, since it was one of its own patents, *cf. Armour & Company* v. *Swift & Company*, 466 F.2d 767, 777-779 (7th Cir. 1972), and we are unwilling to assume that the Examiner was familiar with it, *id.* at 779. Notwithstanding these assumptions, the patentee is correct in emphasizing the improbability that a patent on an unenclosed control would affect the Examiner's evaluation of a means for effectively sealing the opening in a housing during adjustment of the control. We therefore conclude

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[14] (Continued)

with a portion of the barrel securing the driver to the housing, *said portion of the barrel including a flared bearing extending outwardly from* the periphery of the aperture."

The importance of the dust-excluding function is repeatedly emphasized in the specifications. See, e.g., Col. I, lines 17, 44-56, 69-70; Col. II, lines 12-15, 32-35.

[15] CTS cited Patent No. 3,215,303 on "Closure for Openings in the Walls of Electrical Outlet Boxes and the Like" (see especially column 2, lines 59-69) and Patent No. 3,099,057 on "Retaining Fasteners" (see especially column 4, lines 12-19).

that it was a permissible exercise of judgment for CTS to omit the citation of the '478 patent during the processing of the '604 application.

III.

Our reasons for affirming the district court's infringement finding may be briefly stated.

In the device disclosed in the '604 specifications, and in the components actually marketed by CTS, the base of the housing is made of plastic and has the resistance element affixed to it. In contrast, in Piher's PT-15 trimmer, the metal collector also serves as the base of the housing. Unquestionably, if a metal base were used in the CTS device, it would not function. There is, therefore, a rather dramatic difference between the two devices.

The question of infringement, however, is answered by comparing the accused device with the claims of the patent, not with any particular embodiment—even the preferred embodiment—of the invention.[16] The claims in the '604 patent do not require that the base of the housing be a nonconductor. Despite the different arrangement of the elements of the Piher trimmer, each of the elements described in the '604 claims may be found therein. The district court so found, and that finding is supported by the testimony of plaintiff's expert. Most importantly, the arrangement of the base of the housing, the collector, and the resistance element is really not relevant to the question whether the accused device uses a flared bearing on a driver to perform a sealing function. The critical element of the invention is found in Piher's trimmer.

Piher's second attack on the infringement finding was first advanced in its reply brief in this court. Piher points out that the shaft in the PT-15 trimmer protrudes through an opening in the bottom as well as through a second

[16] The phrase "infringement of a patent" is somewhat misleading since it is the claims of the patent which define the boundaries of the patent grant. See Deller's Walker on Patents, 2d Ed., §509, p. 165. Although there are situations in which the scope of the claim may be limited by construing it in the light of the specifications, *see McClain v. Ortmayer*, 141 U.S. 419, 424, we see no reason why the portions of the claim describing the use of the flared bearing to seal in aperture in the housing should be limited by a description in the specifications relating to another wall of the housing.

opening in the top of its housing, and that the flared bearing seals only one of the two holes.[17] It would seem to follow that the housing was not designed to exclude dust. In contrast, the '604 device has only one opening in its housing and the '604 claims refer to "*an* aperture in one of the walls" and describe the location of the flared bearing with reference to the periphery of "*the* aperture."

It is not the fact that the Piher device has two holes rather than only one that casts doubt on the infringement finding; for surely if both holes were sealed with flared bearings, there would be infringement. Rather, it is the fact that there appears to be no seal at all over one of the holes that raises the question whether Piher's housing is intended to exclude dust. But this question was unequivocally answered in the trial court when Piher's counsel acknowledged that Piher had made no attempt to prove that the Piher trimmer does not have a dust excluding housing.[18] Thus, we must assume that the second opening is effectively sealed against dust by a noninfringing means—perhaps merely a close adjustment between the driver and the aperture. That assumption, however, does not undermine the sufficiency of the finding that the flared bearing, when it does perform a sealing function, infringes the '604 patent.

We conclude that the record adequately supports the finding of infringement.

IV.

The fourth and fifth issues relate to the validity of the '285 patent. That patent describes a control which differs from the prior art in two important respects. The metal collector serves as the base of the housing, thereby reducing the number of parts,[19] and the contactor is pinched

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[17] Actually, in the trial court Piher's theory of noninfringement appears to have been that its flared bearing did not even seal one of the holes. The district court rejected that theory and we do not understand appellants to pursue it on appeal.

[18] See Tr. 2346-2347. This position in the trial court was apparently compelled by a representation made by Piher to the Tariff Commission with respect to the dust excluding character of its product.

[19] "Another object of the present invention is to provide a variable resistance control utilizing a minimum number of parts by using the collector as a cover for the housing." Col. 1, lines 73-75; column 2, line 1.

between the collector and the resistance element which are in parallel planes, thereby maintaining a more constant pressure between those two elements than when the spring-like contactor is employed between the two elements arranged concentrically in the same plane.[20] Both of these functions are also found in Piher's PT-15 trimmer.[21] As already noted, there is an interference proceeding pending in the Patent Office to decide the question of priority of invention.

CTS may have been the first to experiment with the '285 construction, but Piher appears to have been the first to exploit it commercially.

In 1967, CTS commenced a "low cost 450" project which eventually resulted in the '285 patent. After rudimentary testing of the handmade model, detailed drawings of the device shown in the '285 patent were prepared, about $20,000 was invested in the acquisition of temporary pro-

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[20] "Yet another object of the present invention is to provide a variable resistance control with the contactor pinched between the resistance element and the collector to thereby maintain equalized contact pressures on the resistance element and collector." Column 2, lines 13-17.

Both of the features mentioned in the text are identified in claim 1 of the '285 patent which reads as follows:

"1. A variable resistance control comprising a housing defined by a skirt and an end wall integral with said skirt, a resistance element lying in a plane and supported flatwise against the end wall of said housing, a collector supported by said skirt and having a diameter slightly larger than the diameter of the resistance element and closing one end of the housing, said collector being provided with an aperture, said collector being substantially flatwise and lying in a plane in spaced parallel relationship to said plane containing said resistance element, a contactor rotatable about an axis and positioned between said resistance element and said collector, and driver means for rotating said contactor whereby upon rotation of said driver means said contractor wipingly engages said resistance element and said collector, said collector rotatably supporting said driver means in said aperture."

[21] These features were plainly identified in the testimony and exhibits presented by plaintiff's expert witness in support of the claim that the PT-15 trimmer infringed the '604 patent. Of course, as CTS argues, the fact that the trimmer which Piher was marketing at the time the litigation was commenced contained the same features as those discussed by the '285 patent does not necessarily prove that earlier models of the trimmer contained the same features. However, an examination of the Piher patent application filed in the United States on July 28, 1969, claiming the benefit of filing dates of July 30, 1968, and May 13, 1968, for corresponding Spanish patents, together with testimony in the record, strongly indicates that these essential features were embodied in Piher's device from its inception.

duction tools, and a number of prototypes were assembled. These samples were tested in May of 1968. Although a defect was found in the samples, CTS determined that the defect was easily correctable and that the samples were commercially satisfactory. There is also testimony that other samples tested in January of 1969 were found to be fully operable. On the basis of that evidence, the district court found that the invention had been reduced to practice in May, 1968, and again in January, 1969. The '285 patent application was filed on March 16, 1970, and the patent issued in 1972. CTS has not yet marketed its "low cost 450" control, but one of its witnesses testified that it plans to do so in the future.

Piher filed a Spanish application on its PT-15 trimmer in July of 1968. In the fall of that year, the witness Adams, who was the manager of International Materials for Motorola, visited Piher's facilities in Barcelona and was shown prototypes of the new trimmer. Toward the end of the year he received samples from Piher and placed an order for a production trial run in January of 1969. A portion of that order was shipped from Barcelona on March 3, 1969, and was delivered to Motorola in April.

Piher's principal attack on the validity of the '285 patent is based on evidence relating to this shipment which left Barcelona more than a year before the date of the application for the patent but did not arrive in the United States until after the critical date. Some of this evidence was admitted and some is in the record as part of Piher's several offers of proof which the trial judge rejected. Before discussing the specifics of that evidence it is important to identify the material issues.

The challenge rests on § 102(b) which defines the so-called "on sale" defense. The statute speaks in terms of "the invention" being on sale in the United States more than one year prior to the application date.[22] It might more

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[22] The text of § 102(b) reads as follows:

"§ 102.

"A person shall be entitled to a patent unless—

* * *

"(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or. . . ."

precisely have referred to a device embodying or disclosing the invention. In any event, the defense is most frequently asserted on the basis of evidence that the patentee's own product was on sale more than a year before the patent application was filed.[23] The statutory purpose in such cases is to make sure that the inventor may not extend the period of patent protection for the commercial exploitation of his monopoly beyond the statutory term.[24]

But the defense may also be predicated on evidence that the invention was disclosed in a product sold by someone other than the patentee more than a year before the filing date. *Dunlop Holdings, Ltd.* v. *Ram Golf Corp.*, ... F.2d ....., No. 74-2024 (7th Cir., Oct. 20, 1975). In such cases, the statutory purpose is to preclude the award of a patent to a person who is not actually the inventor; proof that a product was on sale in the United States more than a year before the application date conclusively places that product in the category of prior art of which the inventor is presumed to have had knowledge. See Judge Duffy's opinion in *Illinois Tool Works, Inc.* v. *Solo Cup Co., Inc.*, 461 F.2d 265, 270-271 (7th Cir. 1972). The "on sale" defense in this case[25] in effect raises the question whether Piher's PT-15 trimmer must be regarded as prior art because it was on sale before the critical date of March 16, 1969.

We first put to one side an argument that CTS repeatedly asserted in the district court and which may have provided an erroneous predicate for some of the trial judge's evidentiary rulings. CTS contended that Piher was required to prove a completed sale in the United

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[23] *See, e.g., Amphenol Corp.* v. *General Time Corp.*, 397 F.2d 431 (7th Cir. 1968); *Frantz Mfg. Co.* v. *Phenix Mfg. Co.*, 457 F.2d 314 (7th Cir. 1972); *Dart Industries, Inc.* v. *E. I. DuPont De Nemours and Co.*, 489 F.2d 1359 (7th Cir. 1973); *The Red Cross Mfg. Corp.* v. *Toro Sales Co.*, ... F.2d ....., No. 73-1900 (7th Cir., November 12, 1975).

[24] "The policy underlying the 'on sale' bar is to prevent an inventor from holding back the secrets of his invention from general public knowledge while at the same time exploiting it commercially, thereby extending the duration of his legal monopoly." *The Red Cross Mfg. Corp.* v. *Toro Sales Co., supra*, slip op. at 6.
See, also, Frantz Mfg. Co. v. *Phenix Mfg. Co., supra*, 457 F.2d at 320.

[25] Since the "on sale" issue was raised by Piher's counterclaim, it is not actually a "defense" in this case; however, since the issue is normally raised by the defendant, it seems appropriate to follow the practice of referring to it as a defense.

States prior to the critical date. Admittedly, Piher proved no such sale. But if it was then offering to prospective purchasers in the United States a product which (a) embodied the '285 invention and (b) was complete in the sense that it represented a reduction of the invention to practice, the invention was on sale within the meaning of the statute and the '285 patent is invalid.[26]

There is substantial evidence in the record supporting the conclusion that Piher's PT-15 trimmer disclosed the essential elements claimed in the '285 patent. Piher's trimmer was described in detail by the CTS expert who explained why it infringed the '604 patent; his testimony and the exhibits he prepared clearly disclosed the use of a metal collector as a base for the housing, and also the contactor pinched between the collector and the resistance element in separate parallel planes. Moreover, in its original complaint, CTS alleged that the PT-15 trimmer infringed the '285 patent.

CTS points out, however, that the fact that the invention was disclosed in Piher's trimmer in 1972 when the suit was filed does not necessarily establish the fact that it was embodied in any device which was on sale prior to March 16, 1969. For there is evidence in the record that the trimmer has been modified from time to time, and Piher had the burden of proving that it reduced the concept to practice before the critical date. *See Dart Industries, Inc.* v. *E. I. DuPont De Nemours and Co.*, 489 F.2d 1359, 1364 (7th Cir. 1973). Thus, the character of the devices shipped by Piher on March 3, 1969, was of critical importance.

Adams testified that after those devices were delivered to Motorola in April of 1969, they were turned over to Gunar Klass for evaluation. Klass testified that he conducted a series of tests in April, May and June of 1969. CTS seems to have persuaded the trial judge that evidence regarding these tests was irrelevant because the product did not arrive in the United States until after the critical date.[27] CTS convinced the trial judge that a copy of the

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[26] See cases cited in n. 23, *supra*.

[27] "MR. WYSS: I object to the so-called offer of proof for a number of reasons. First of all, this device, according to the witness' own testimony, was — if it was — received by him on

Motorola purchase order issued on January 22, 1969, relating to the March shipment was inadmissible because it did not constitute "the best evidence" of what Motorola had ordered, and its relevance was not manifest from the face of the document. CTS also persuaded the court to exclude testimony by Klass, who had been responsible for Motorola's testing of the Piher device, in which Klass described the essential features of that device.[28] The court also sustained objections to the admissibility of one of the devices which the witness identified as having been tested in 1969 on the ground that it had not been in the personal custody of the witness for about a year, but rather had been in the custody of Motorola's patent department, and there was no absolute assurance that the offered exhibit was the one he had tested. The arguments over the admissibility of these exhibits and this testimony were extensive and we are not entirely sure that we understand the basis for the various restrictive rulings made by the trial judge. We have no doubt, however, that the purchase order was relevant and that the fact that it was a carbon rather than

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[27] (Continued)

or about April 11, 1969, so it is much too late for anything in connection with this lawsuit and is therefore, under the provisions of Rule 43(E) not admissible on any ground.

MR. ROHRBACK: (C).

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THE COURT: I sustain the objection of the plaintiff to the offer of proof made by the defendant in connection with the offer of Defendant's Exhibit 48 for identification." (Tr. 1602-1603).

[28] During the offer of proof, the witness disassembled the exhibit while he was on the witness stand and identified the collector as a part of the base and the contactor's location pinched between the resistance element and the collector. The testimony was in part:

"Q Would you tell us what is inside Defendant's Exhibit 48 for identification?

A Inside we see the contactor, which is mounted on the plastic rotor. I will remove that, together with the rotor, and we also see the resistive element with the two terminals attached to them internally.

Q Where is the resistance element?

A The resistance element is mounted within the plastic body, cavity and is retained by a terminal on both sides.

Q Where was the contactor with respect to the resistive element and the collector when you opened up?

A The contactor is —

Q Defendant's Exhibit 48 for identification.

A The contactor is positioned on top of the rotor and is between the resistance element and the collector." (Tr. 1601-1602)

a ribbon copy did not justify its exclusion.[29] Moreover, the lengthy testimony of the witness Klass, which we have studied with care, contains sufficient assurance that the offered exhibit was one of the devices ordered in January and received in April to have justified its admissibility.[30]

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[29] The misnamed "best evidence" rule is found in Rules 1002, 1003, and 1004 of the new Federal Rules of Evidence. Since the excluded copy of the purchase order was a duplicate, its admissibility was covered by Rule 1003, which provides:

"A duplicate is admissible to the same extent as an original unless (1) a genuine question is raised as to the authenticity of the original or (2) in the circumstances it would be unfair to admit the duplicate in lieu of the original."

A "duplicate" is defined in Rule 1001(a)(4) as:

". . . a counterpart produced by the same impression as the original, or from the same matrix, or by means of photography, including enlargements and miniatures, or by mechanical or electronic re-recording, or by chemical reproduction, or by other equivalent techniques which accurately reproduces the original."

We find no basis in the record for questioning the authenticity of the purchase order. At the time the purchase order was offered, a Motorola employee, Adams, was on the stand and in the offer of proof testified that the order was made by a Mr. Pinter under Adams' direction. Adams also testified as to when the order arrived, what devices were ordered (Motorola part numbers appear on the order rather than Piher numbers), and when he had first seen the Piher devices which are the subject of the order. Although there is no direct testimony describing the document as a "carbon copy," in the absence of any evidence to the contrary, we draw this inference from the copy of the document which was offered for examination in light of the testimony of the witnesses from Motorola. CTS, however, on remand, retains the right to question the document's authenticity.

[30] "By Mr. Jones:

Q Mr. Klass, I hand you Defendant's Exhibit 48 and ask you to describe it from its visual appearance from the exterior.

A It is a PT type — PT-15 Piher molded housing potentiometer, has our production part number on it, has our test lab number 4 test tag on it, has a molded-in Piher Spain name on it.

Q Can you tell us what parts are visible from the exterior?

A The parts visible from the exterior is the molded plastic body, the collector, which is sealed with the body, has a plastic rotor and has two terminals.

Q Is there any doubt in your mind, Mr. Klass, as to whether or not that is the same number 4-PT trimmer that was tested in or about April of 1969 and reported on in Defendant's Exhibit 47 for identification?

A That is my testimony. That is the device I removed from my —

THE COURT: Did you hear the question?

THE WITNESS: Please read it.

(Question read.)

A There is no doubt in my mind." (Tr. 1598-1599)

For discussion of identification and chain of custody of "Real" evidence in civil cases see Admission of Demonstrative Evidence, 61 Nw ULR 472, 478-479 (1966).

As CTS argues, the record does not entirely foreclose the remote possibility that this particular device was mislabeled, or confused with another device when it was in the custody of Motorola's patent department; such a possibility affects the probative value of the exhibit, but in view of the positive character of the witness's testimony that it was one of the devices which had been tested in 1969, and that it was one that had been received pursuant to the January order, it should have been admitted. Surely, in a case tried to the court without a jury, discretion in such evidentiary rulings should be exercised in favor of admissibility, particularly when the record is more apt to be encumbered by extensive argument over issues of admissibility than by the evidence itself.[31]

If the physical exhibit identified by Klass had been admitted, and if the trial court had accepted his oral testimony presented in an offer of proof, the evidence would have been sufficient to support findings of fact establishing Piher's "on sale" defense. For that evidence tended to prove that the device which Motorola received in the United States in April of 1969 disclosed the '285 invention. Moreover, Klass' testimony about the tests performed under his direction, together with evidence that these devices were shipped from Barcelona on March 3, 1969, was sufficient to justify the inference that the Piher control had been reduced to practice prior to the critical date.[32] Thus, the erroneous evidentiary rulings prevented Piher from presenting a possibly meritorious defense.[33]

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[31] *See generally Brubeck* v. *Pennsylvania R. Co.*, 346 F.2d 238, 241 (7th Cir. 1965); *Reid* v. *Quebec Paper Sales & Transp. Co.*, 340 F.2d 34 (2d Cir. 1965); *New York Life Ins. Co.* v. *Harrington*, 299 F.2d 803, 806 (9th Cir. 1962); McCormick, Evidence, 1954, § 60; see also Davis, Hearsay in Nonjury Cases, 1970, 83 Harv. L. Rev. 1362.

[32] We have not found it necessary to decide whether error was committed in the exclusion of the reports written in Spanish by the former president of Piher describing his sales activities in the United States during early 1969. Our disposition of the case will enable Piher to make a fresh offer of this evidence and the trial judge who will hear the new trial to make a fresh appraisal of these evidentiary rulings which appear to have been unnecessarily restrictive in a case tried by the court without a jury.

[33] Although a substantial portion of the cross-examination of Klass was directed to demonstrating that most of the tests were not completed until May or June, instead of during the month of April, as he testified on direct examination, the timing of those tests is really of no relevance if it is assumed that Piher's evidence was adequate to sustain a finding that the devices being tested had left Piher's factory in a completed form prior to the critical date.

Piher argues that we should therefore hold the '285 patent invalid. Such a holding, however, would require us to make the requisite findings of fact in the first instance and to conclude that Piher has met its burden with clear and convincing evidence. As we have indicated, if the proffered testimony is credited, it appears that Piher will prevail. But the question of credibility and the interpretation of the exhibits are matters that must be decided in the first instance by a trial judge. We therefore remand for a new trial of all issues raised by Piher's on sale challenge to the validity of the '285 patent.

V.

As already noted, CTS has never marketed its "low cost 450" control commercially. Moreover, there were defects, albeit correctable, in the prototypes which CTS tested. Piher therefore argues that the invention was not useful, that the best mode of carrying it out was not described in the '285 patent specifications, and that the invention was abandoned. The trial judge rejected each of these contentions and we cannot say that his findings are clearly erroneous.

The fact that there was a defect in the prototypes surely does not demonstrate that the *invention* was not useful. Indeed, since the basic features of the invention appear to be embodied in Piher's PT-15 trimmer—as may fairly be inferred from Piher's on sale defense and CTS' original charge that the PT-15 infringes the '285 patent—and since Piher's trimmer is evidently a commercial success, it seems logical to infer that the subject matter of the invention is useful within the meaning of § 102.

Similarly, even if the CTS prototypes are not the best possible embodiment of the invention, we find nothing in the record to support the argument that the inventors contemplated a better mode than that disclosed in the specifications. Section 112 merely requires that the patent disclose "the best mode contemplated by the inventor of carrying out his invention."

Finally, the fact that CTS promptly filed its patent application forecloses the contention that the invention was abandoned within the meaning of § 102(c). There are,

of course, cases in which the character of the commercial exploitation of an invention will be relevant to the issue of abandonment, *cf. Dunlop Holdings, Ltd.* v. *Ram Golf Corp.*, ... F.2d ....., No. 74-2024 at 6 (7th Cir., Oct. 20, 1975), but if the application is promptly filed and diligently prosecuted, the decision to postpone commercial development does not constitute abandonment.

VI.

The district court refused to award costs to CTS, even though it prevailed on all issues decided by the district court. CTS has therefore filed a cross appeal, relying heavily on our recent decision in *Popiel Bros., Inc.* v. *Schick Electric, Inc.*, 516 F.2d 772 (1975). In view of our remand for a new trial of the on sale defense, we believe that the question of what costs, if any, CTS should recover, can await the conclusion of the proceedings in the trial court.

The judgment of the district court is affirmed in part and reversed in part.

A true Copy:

Teste:

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Clerk of the United States Court of Appeals for the Seventh Circuit

APPENDIX "B"

UNITED STATES COURT OF APPEALS

For the Seventh Circuit
Chicago, Illinois 60604

January 26, 1976

BEFORE

Hon. TOM C. CLARK, *Associate Justice**
Hon. JOHN PAUL STEVENS, *Circuit Justice***
Hon. ROBERT A. GRANT, SR. *District Judge****

No. 75-1100

CTS CORPORATION, a corporation,

Plaintiff-Appellee,

v.

PIHER INTERNATIONAL CORPORATION, a corporation; and PIHER SOCIEDAD ANONIMA, a corporation,

Defendants-Appellants.

Appeal from the United States District Court for the Northern District of Illinois, Eastern Division — No. 72 C 1891

On consideration of the defendants-appellants' petition for rehearing filed in the above-entitled cause,

IT IS ORDERED that the defendants-appellants' petition for rehearing in the above-entitled appeal be, and the same is hereby, DENIED.

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* Associate Justice Tom C. Clark of the Supreme Court of the United States (Retired) is sitting by designation.

** Mr. Justice Stevens participated initially as Circuit Judge, and on and after December 19, 1975 as Circuit Justice.

*** Senior District Judge Robert A. Grant of the Northern District of Indiana is sitting by designation.

APPENDIX "C"

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

CTS CORPORATION, a corporation,

Plaintiff,

v.

PIHER INTERNATIONAL CORPORATION, a corporation, and PIHER SOCIEDAD ANONIMA, a corporation,

Defendants.

No. 72 C 1891

MEMORANDUM OF DECISION

JULIUS J. HOFFMAN, *Senior District Judge.* This is an action for patent infringement with counterclaims of invalidity and non-infringement. Original jurisdiction of patent cases is conferred on the District Courts by 28 U.S.C. § 1338(a). Venue is properly laid in this district under 28 U.S.C. § 1400(b). The plaintiff, CTS Corporation, is an Indiana corporation with its principal place of business at Elkhart, Indiana. Defendant, Piher International Corporation (PIC or Piher), an Illinois corporation, has a regular and established place of business in Park Ridge, Illinois. The second named defendant, Piher Sociedad Anonima, (PSA) is a Spanish corporation.

Originally, plaintiff alleged infringement of four United States Letters Patent, 2,740,027 ('027), 3,375,478 ('478), 3,518,604 ('604) and 3,670,285 ('285). After answer, stipulation, trial and amended complaint and answer, respectively, infringement of the '027, '478, and '604 patents remained at issue, together with

counterclaims denying validity and infringement of the '027 and '604 patents, infringement of the '478 patent, and validity of the '285 patent. Additionally, to permit joinder of PSA as a party defendant, plaintiff alleged that Piher was the "alter ego" of the Spanish corporation, PSA. The prayer is for an accounting for damages, including costs and attorneys' fees, and injunctive relief.

I. Piher Sociedad Anonima (PSA)

Plaintiff alleges that PSA is the "alter ego" of Piher and therefore properly joined as a defendant. Facts relating to this issue must be viewed in their entirety, and if the appearance of PIC's autonomy is merely superficial, PSA is properly before this court. *Frazier v. Alabama Motor Club, Inc.*, 349 F.2d 456 (5th Cir. 1965). *See also S.O.S. v. Bolta*, 117 F.Supp. 59 (N.D. Ill. 1953). The network of interrelationships between Piher and its Spanish parent is ample foundation for the conclusion that Piher was autonomous in form only. The facts show joint ownership, interlocking officers and directors, employee confusion as to the source of compensation, and customer treatment of the corporations as identical.

The wholly-owned subsidiary of PSA, Piher, was organized, by its parent, as an Illinois corporation on July 11, 1968 to serve as a marketing organization in the United States. Sales by Piher were restricted to PSA products. PSA designated Piher's office as its own on invoices and business correspondence. Two brothers, Juan Luis Heredero and Jose Antonio Heredero, own the substantial portion of both corporations. One brother is a director of PSA and an officer of Piher, while the other has been PSA's chairman of the board at the same time he was vice-president of Piher.

Other personnel serve in interrelated capacities. Piher's president, Garcia Nietro, is PSA's export manager, as was his predecessor Ricardo Balil. During their respective terms as president of Piher, Nietro and Balil resided in Spain. The managing director of Piher served as the PSA managing director for the United

States. Customers apparently dealt with officers of Piher not in their capacity as officers of Piher, but as representatives of PSA. Piher employees were unsure whether their compensation came from Piher or PSA. The evidence shows that one company sometimes paid obligations of the other. For example, PSA paid the expenses of Balil to travel to the United States to testify on deposition in this suit. Viewing these facts in their entirety, the court must find that Piher and its parent are, for jurisdictional purposes in this action, the same.

II. Patent No. 3,375,478 ('478)

United States Letters Patent No. 3,375,478 issued in the names of John Van Benthuysen and Wayne A. Barden on March 26, 1968. Plaintiff holds all rights in this patent for variable resistor controls. Because of the small size of these devices, the plaintiff marked the numbers of the '478 patent either on containers for the resistors or on inserts placed in the containers.

28 U.S.C. § 271 defines an infringer as any one who, without authority, makes, uses or sells any patented invention within the United States during the term of the patent. The "claims measure the invention." *Continental Paper Bag Co. v. Eastern Paper Bag Co.*, 210 U.S. 405 (1908). The general rule is that if the accused device falls clearly within the claim, infringement is made out. 7 Deller's *Walker on Patents* § 511. *Graver Tank Co. v. Linde Air Products Co.*, 339 U.S. 605 (1950). The plaintiff contends that the accused PAB 15 devices sold by defendants in the United States infringe claims 1, 3, 4, 7, 8, and 10 of the '478 patent.

Defendants' Model PAB 15 controls reproduce almost exactly two of plaintiff's CTS Model 201 Series controls. Plaintiff's expert demonstrated that the elements of claims 1, 2, 3, 7, 8, and 10 of the '478 patent correspond in term and substance to the elements of each of the several forms of defendants' Model PAB 15 controls. Each element of the two forms of defendants' Model PAB 15 performs the same function in the same manner

as the corresponding element in each of claims 1, 2, 3, 7, 8, and 10 of the '478 patent.

While defendants did not refute this testimony establishing the similarity between plaintiff's claims and the elements of defendants' PAB 15 controls, they did argue that no infringing act occurred in the United States after the '478 patent was issued on March 18, 1968.

Prior to the issue of the patent, PSA obtained from Motorola Corporation samples of plaintiff's Model 201 Series variable resistors. From these samples, it produced the PAB 15 controls. Defendants sold approximately 200,000 of the PAB 15's to Motorola Corporation, who placed its last order with PSA March 8, 1968, ten days before the patent issued.

The majority were then delivered to Motorola, in the United States, in or after mid-April of 1968, after defendants had been notified of the '478 patent and their infringement thereof. Sales activities continued in the United States until the summer of 1969. Motorola subsequently returned most, if not all, of the devices and was reimbursed by a check drawn by Piher. Although the actual damages may therefore be slight, the court finds that plaintiff has proved infringement under 35 U.S.C. § 271.

III. Patent No. 2,740,027 ('027)

CTS holds all rights in United States Letters Patent No. 2,740,027 ('027) issued in the names of Wilbert H. Budd, Robert A. Stackhouse and Herbert L. Slough on March 27, 1956. The patent has three basic components: a variable resistor control, trimmer potentiometer, and metal encased coil. It allows temporary mounting of the components in proper position until they are permanently soldered into a circuit panel.

Plaintiff marked the numbers of the '027 patent either on containers or on inserts included with the devices.

Plaintiff alleges that defendants' PT 15 devices infringe claim 5 of the '027 patent. The questions presented are the infringement of claim 5 and the validity of the '027 patent, the validity issue having been raised via counterclaim for declaratory relief.

A. Infringement

As noted earlier, if the accused device falls clearly within the claim, infringement is made out. *Graver Tank Co. v. Linde Air Products Co.*, 339 U.S. 605 (1950). When the accused device achieves substantially the same result in substantially the same way as the patented device, the devices are the same in the eyes of patent law. *King-Seeley Thermos Co. v. Tastee Freeze Industries, Inc.*, 357 F.2d 875, 880 (7th Cir. 1966) *Graver, supra*, 339 U.S. at 608, 609. Plaintiff's expert testified that all elements of claim 5[1] of the '027 patent read in term and substance upon corresponding elements of

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[1] Subclassified according to its elements, claim 5 reads:

"In a circuit component for radio and television sets having a rotatable control shaft:

[1] supporting means for the component fixed with respect thereto and having panel engaging abutments with surfaces thereon lying in a common plane spaced from the control shaft but parallel to its axis, said abutments being adapted to seat upon a panel and thereby position the control shaft of the component at a definite distance from the panel;

[2] terminals for the component projecting therefrom substantially perpendicularly to and beyond said plane of the panel engaging surfaces of said abutments whereby said terminals are adapted to enter holes in a panel upon which the abutments seat; and

[3] snap-in fingers on the supporting means projecting therefrom beyond the plane of the panel engaging surfaces of the abutments to have detent like engagement in holes in a panel upon which the abutments seat, and thereby coact with said abutments to hold the component on the panel with its control shaft and terminals properly positioned with respect to the panel."

defendants' PT 15 LB. As will become apparent, corresponding elements perform the same function(s) in the same way.

The unique contribution of '027 is an improved structure for mounting components on a printed circuit board or panel. It permits temporary mounting, in proper position, until the control can be permanently soldered. The mounting structure on defendants' Model PT 15 LB control achieves the same results with essentially the same structure. As in '027, the control shaft on Model PT 15 LB is adapted for positioning with its axis parallel to a printed circuit panel. Also, the Model PT 15 LB has "supporting means" with panel engaging abutments for accurately positioning the control and limiting the penetration of the terminals. It has "snap-in" fingers to provide detent like engagement with the panel.

In the patented structure, the snap-in fingers, formed on the supporting means, also serve as terminals providing connection to the ground conductor portion of the printed circuit panel. In the Model PT 15 LB, the snap-in fingers are formed on the ends of the terminals, one of which is normally a ground terminal joined to a ground conductor on the printed circuit panel. The difference between the devices is that on defendants' PT 15 LB the snap-in fingers are formed directly on each terminal of the variable resistor control, whereas in the patented structure, the snap-in fingers are formed on the supporting means. Defendants' device combines the snap-in fingers and terminals, eliminating the need for the supporting legs found on plaintiff's device. This difference is not legally significant. The accused device achieves substantially the same result in substantially the same way as the patented device. *King-Seeley Thermos Co., supra.* More narrowly put, infringement is not avoided by combining functions into one part where separate parts in the patented device performed the functions now combined. *Zysset v. Popeil Brothers, Inc.*, 276 F.2d 354 (7th Cir. 1960). Even acknowledging the difference, claim 5 reads in term and substance upon defendants' structure. For example, the snap-in fingers

on defendants' PT 15 LB controls provide detent like engagement with the panel, thereby positioning the control on the panel until permanent soldering is complete. Defendants sold the accused device in the United States after issuance of the patent and notification of infringement. The court finds, therefore, that plaintiff has proved infringement of claim 5 of '027.

B. Validity

Defendants nevertheless claim that '027 is invalid under 35 U.S.C. § 103. The burden rests on them to overcome, by clear and convincing evidence, the statutory presumption of validity. 35 U.S.C. § 282; *Mumm v. Decker & Sons*, 301 U.S. 168, 171 (1937); *Ortman v. Maass*, 391 F.2d 677, 681 (7th cir. 1968). A patent is valid if the differences between the prior art and the claimed subject matter are such that the subject matter as a whole would not have been obvious to a person having ordinary skill in the art to which the subject matter pertains at the time when the invention was made. 35 U.S.C. § 103, *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966).

To support its counterclaim for declaratory judgment of invalidity under § 103, defendant offered testimony of a patent lawyer, four reference patents and the prior art listed by the Patent Office. This evidence does not sustain the heavy burden of proof imposed on the defendants by 35 U.S.C. 282.

First, the conclusion of defendants' witness, a patent lawyer, that '027 was obvious in light of the prior art is entitled to no weight. Disqualified at the trial, the witness lacked qualifications as an expert on electronics components, his technical education being limited to one or two basic mathematics and drafting courses. Moreover, defendants did not comply with Rule 26(e)(1)(b), Federal Rules of Civil Procedure, requesting them to supply the substance and subject matter of this witness' testimony in response to plaintiff's interrogatories. Even if admitted, the offer would have

substantive defects. For example, the witness' conclusion made no reference to the subject matter as a whole, obviousness to a person of ordinary skill in the art, and the time of invention, all important elements of 35 U.S.C. § 103, the basis of the counterclaim. In 1968, the Court of Appeals for the Seventh Circuit noted its reluctance to rely on ". . . the sole testimony in this regard . . . provided by a patent lawyer who admittedly was not an expert . . ." *National Dairy Products Corporation v. Borden Company*, 394 F.2d 887, 890 (7th Cir., 1968).

It was, on the other hand, the opinion of plaintiff's expert that the subject matter claimed in '027 patent would not have been obvious to a person of ordinary skill in the art at the time when the respective inventions were made. *See Thexton Manufacturing Company v. Soland*, 39 USPQ 104, 107 (Minn. 1938).

Three of the four reference patents cited by defendant were not admitted.[2] The one reference admitted, O'Callaghan, United States Letters Patent No. 2,169,708 relates to a structure for mounting a coil shield upon a metal chassis, not an insulating board generally used with printed circuits. Plaintiff's expert testified that the

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[2] Lazzery et al., United States No. 2,742,627; Del Camp United States No. 2,790,961; Hathorn United States No. 2,754,486.

The ground for the objection was that each of the patents was issued after '027 was filed. Additionally, no foundation was laid. Plaintiff's counsel offered to withdraw the objection if, prior to filing post trial memoranda, defendants' counsel could offer assurance that the applications for the patents were not substantially changed during their prosecution. Counsel for plaintiff has indicated no such assurance has been received.

Moreover, none of these rejected patents relates to variable resistor controls, and none is directed to accurate temporary positioning of the control shaft. None shows abutments on supporting means the purpose of which is to engage the panel to enable positioning of the control shaft. None shows an electronic circuit component having a rotatable control shaft. None of the references shows certain elements of claim 5 (see footnote 3, infra).

"shoulders" on O'Callaghan, which perform the detent like holding function, are "radically different" from the abutments of '027. Moreover, O'Callaghan is not directed to accurate temporary positioning of the control shaft. It does not show abutments on supporting means the purpose of which is to engage the panel to enable positioning of the control shaft.

No evidence shows that the prior art patents listed by the Patent Office anticipated claim 5 of '027. Each fails to show several elements of claim 5.[3].

IV. Patent No. 3,518,604 ('604)

A. Infringement

United States Letters patent No. 3,618,604 issued in the names of Thomas R. Beaver and John D. Van Benthuysen on June 30, 1970 for "Electrical Component" on an application filed February 12, 1968. CTS holds all rights in the '604 patent. Plaintiff marked the '604 patent number on either containers or inserts. The plaintiff alleges infringement of '604 under 35 U.S.C. § 271. The question presented is thus whether defendants' PT 15 device embodies the '604 patent and whether it was "made, used or sold" in the United States. Additionally, defendants counterclaim for declaratory judgment of invalidity.

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[3] The elements are (1) "panel engaging abutments with surfaces thereon lying in a common plane spaced from the control shaft but parallel to its axis, said abutments being adapted to seat upon a panel and thereby position the control shaft of the component a definite distance from the panel." (2) terminals projecting "substantially perpendicular to and beyond said plane of the panel engaging surfaces of said abutments whereby said terminals are adapted to enter holes in a panel on which the abutments seat." and (3) snapping fingers projecting "beyond the plane of the panel engaging surfaces of the abutments to have detent like engagement in holes in a panel upon which the abutments seat, and thereby coact with said abutments to hold the component on the panel with its control shaft and terminals properly positioned with respect to the panel."

The PT 15 LB was sold by the defendant in the United States after June 30, 1970, the date the '604 patent issued. The invention represented by '604 achieved an efficient, relatively inexpensive variable resistor control. Essentially, the invention is comprised of a housing with closure member forming the housing wall. An aperture extends through one wall on the housing to accommodate a barrel portion of the driver. CTS markets the '604 invention as its Model 360 Series Control.

Every element in Claims 1, 5, 7, 8, and 10 of the '604 patent reads upon a corresponding element of defendant's Model PT 15 LB control. Graver Tank v. Linde Air Products Company, supra. The elements in the PT 15 LB achieved the same results as corresponding elements in the '604 invention. See King-Seeley Thermos Company v. Tastee-Freez Industries, Incorporated, supra. The PT controls include, for example, a housing on one end which is a metal closure forming a wall of the housing. Also an aperture for accommodating the barrel portion of the driver appears in the end of the closure member. The barrel portion protruding beyond the aperture is flared outward, forming, together with the housing, a seal against dust. The driver is composed of heat deformable material.

The defendant offered, to rebut plaintiff's claim of infringement as to '604, the testimony of the patent lawyer, Mr. Lucas. As noted above, the Court disqualified Mr. Lucas because of insufficient qualifications as an expert on electronic components. See National Dairy Products Corporation v. Borden & Company, supra. Even if received, the testimony of Mr. Lucas would not have been persuasive as to infringement of '604. During an offer of proof, Lucas stated that it was his opinion that the claims of the '604 patent are not infringed by an electrical component with a shaft secured in one wall of the housing by a flange formed from the shaft, if the flange abuts at right angles from the axis of the shaft. Regardless of whether the flange is perpendicular to the axis or tapered at less than 90 degrees, it performs the same function in the same way.

B. Validity

Defendants seek declaratory judgment of invalidity as to the '604 patent, alleging that the patent fails to comply with 35 U.S.C. § 103. It bears repeating that defendants must show that the differences between the prior art and the claimed subject matter are such that the subject matter as a whole would not have been obvious to a person having ordinary skill in the art at the time the invention was made. 35 US.C. § 103, *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). Defendants have not met their heavy burden of proof. 35 U.S.C. § 282; *Mumm v. Decker & Sons, supra., Ortman v. Maass, supra.*

Plaintiff's expert testified unequivocally that the subject matter would not have been obvious to a person of ordinary skill in the art at the time the invention was made. In contrast, defendants, through offer of proof, offered the testimony of the patent lawyer disqualified by the court for reasons noted earlier.[4]

Although defendants attempted to show that another form of plaintiff's Model 201 Series controls using a hollow shaft with a deformed end portion was prior art to the '604 patent, they failed to establish, by clear and convincing evidence, the dates of first sale or public use of this device. There are no available records or testimony showing any sales or public use, as distinguished from date coding,[5] of the CTS Model 201 Series controls having a hollow shaft prior to February 12, 1967 (more than one year prior to the application for the '604 patent). *See, Julian v. Driving Systems Co.*, 346 F.2d 336 (7th Cir. 1965).

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[4] See text at pages 10-11. Even if the testimony had been admitted, it would not have been persuasive. The witness misstated contents of claim 1 of '604. Also, he contradicted the dictionary definition, cited by him, of the important term "flared bearing."

[5] The date coding applicable to plaintiff's devices shows only the approximate date of the stamping or making of a particular part. It does not indicate the assembly date of the complete component. The date coding does not show the sale date

(Footnote continued on following page)

Defendants relied principally on the references listed by the Patent Office at the end of the '604 patent, and the '478 patent. The plaintiff's expert clarified the differences between the subject matter of Claims 1, 5, 7, 8, and 10 of the '604 and the prior art cited which fails to show a variable resistor control with a driver equipped with a barrel protruding through an aperture in the wall of an enclosed housing, the protruding portion of which is deformed into a bearing that seals the housing to exclude dust.

Moreover, because the '478 patent discloses fewer of the claimed elements, it is less pertinent than the Patent Office references.

Admittedly, the prior art relied upon by defendants includes a flared bearing or deformed portion. The purpose of the flared bearing in the prior art, however, was holding parts together, not providing a dust-excluding seal for an enclosed housing. At the time '604 issued, deformed portions or flared bearings for holding parts were old and well-known. Moreover, plaintiff's expert testified that the prior art cited does not anticipate or fully meet the subject matter of any of claims 1, 5, 7, 8, or 10 of the '604. Even during their offer of proof, defendants offered no evidence tending to show that any of the references anticipated the subject matter of these claims.

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[5] *Continued*
of the component or the date of placement in public use. Moreover, the component may never be sold or used or may be sold or used more than a year following the date.

Defendants' reliance on plaintiff's answer to defendants Interrogatory 60 to establish date of sale or public use is misplaced. That set of interrogatories related to antitrust issues no longer in the case, not sales of hollow shaft controls.

V. Patent No. 3,670,285 ('285)

The remaining questions focus on defendants' counterclaim for declaratory judgment of invalidity of plaintiff's United States Letters Patent No. 3,670,285. The counterclaim is brought under 35 U.S.C. §§ 101, 102(b) and (c) and 112.

Defendants assert that '285 lacks utility and therefore validity under 35 U.S.C. § 101. '285 was developed with the intent of producing a resistor that could be manufactured less expensively than other CTS resistors. While the court acknowledges evidence indicating that some of the models produced did not perform satisfactorily on certain "gradient" tests, defendants have not met the heavy burden of proof required to establish lack of utility. For a patent to be "useful" under § 101, it need not be perfect for commercial use. *Field v. Knowles*, 183 F.2d 593 (C.C.P.A. 1950). Mr. Barden, vice president of CTS in charge of engineering and development, testified that samples of '285 were commercially satisfactory as a variable resistor control. Moreover, an original model functioned properly, with test results confirming this result on subsequent occasions.

Defendants have also failed to sustain the burden of proving invalidity under 35 U.S.C. § 112. That section provides in part:

> "The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same . . ."

The court has not had the benefit of expert testimony as to whether the specifications satisfy Section 112. *See Lorenz v. General Steel Products Company, Inc.*, 337 F.2d 726 (5th Cir. 1964). Defendants' reliance upon the failure of some of the samples is, without more, inadequate to permit the court to find the specifications defec-

tive under the statute. *See Williams v. Administrator of National Aeronautics and Space Administration*, 463 F.2d 1391 (C.C.P.A. 1972).

Defendants also contend that the Piher PT 15 variable resistor was on sale or sold in the United States more than a year prior to the filing date of the application for the '285 patent, March 16, 1970, and therefore invalid under 35 U.S.C. § 102(b). Under § 102(b), a person is entitled to a patent unless the invention was ". . . in public use or on sale in this country more than one year prior to date of the application for patent in the United States." The standard required for proof that the invention of '285 was in public use or placed "on sale" prior to application is "clear and convincing" evidence. *Julian v. Drying Systems Co.*, 346 F.2d 336, 338 (7th Cir. 1965).

While it is settled that a consummated sale is unnecessary, and the placing "on sale" only is required, *Burke Electric Co. v. Independent Pneumatic Tool Co.*, 234 F. 93 (2nd Cir., 1916), *Wende v. Horine*, 225 F.501 (7th Cir., 1915), it is also established that a device must have existed as a finished article for sale, on hand ready for delivery. *Burke, supra; Conn. Paper Products, Inc. v. N.Y. Paper Co.*, 39 F. Supp. 127 (Md.), modified on other grounds, 127 F.2d 423, (4th Cir. 1942). The device must be "on sale" in this country. 35 U.S.C. § 102(b).

The evidence shows that Piher received part (plastic housing) of a proposed PT variable resistor in October, 1968. Merely a part of a device is insufficient predicate for a finding of "on sale." Part of a device cannot anticipate a patent, or be ready for delivery, even assuming offers for sale. *See, Reo Motor Car Co. v. Gear Grinding Machine Co.*, 42 F.2d 965 (6th Cir. 1930). No complete samples were available in the United States until March 25, 1969, less than a year prior to the application date. Moreover, defendants' witness, Ricardo Balil, former president of Piher, admitted that samples sent to Motorola as late as July, 1969, although complete, were unsatisfactory.

Defendants' evidence does show some sales activity more than a year prior to the application date. For example, Balil testified to quoting prices to prospective customers beginning in January, 1969. There is evidence that a sample was ordered March 3, 1969, and sent from Spain thereafter. On balance, however, and with defendants heavy burden of proof in mind, the court must find that defendants have failed to prove invalidity under § 102(b). There is no clear and convincing evidence of an anticipating device that was complete and ready for delivery within the statutory period.

Finally, defendants contend under 35 U.S.C. 102(c) that plaintiff abandoned '285. Section 102(c) provides that a person shall be entitled to a patent unless he has "abandoned the invention." In theory, an inventor abandons an invention when he has dedicated his invention to the public. *See, 2 Deller's Walker on Patents* § 128 (2d ed. 1964). "No abandonment of an invention after the issue of Letters Patent has ever been judicially decided to exist in the United States." Id. § 151. Failure commercially to exploit an invention of the ' 285 patent does not establish abandonment. *Imperial Brass Mfg. Co. v. Bonney Forge & Tool Works*, 38 F. Supp. 829 (E.D. Pa. 1941).

Applying these principles, the court finds that defendants have not proved abandonment either prior to or after '285 issued. It is true that CTS has yet to bring '285 into production. However, the device had been "reduced to practice" in May, 1968 and again in January, 1969. *See Dart Industries, Inc. v. E. I. DuPont De Nemours and Co.*, 489 F.2d 1359, 1365 (7th Cir. 1973), *quoting* 24 Stan. L. Rev. 730, 743 (1972) (invention reduced to practice when there is a "completely operable physical embodiment"). Delay in filing application after reduction to practice (not more than two years in the instant case) does not constitute abandonment. *Lowell v. Peer*, 148 F.2d 212, 213-214 (CCPA, 1945) (over 4 years). Without more, the court cannot conclude that CTS' failure to exploit commercially '285 amounts to a dedication of the device to the public.

DATED: September 25, 1974

APPENDIX "D"

June 30, 1970 T R. BEAVER ET AL 3,518,604
ELECTRICAL COMPONENT
Filed Feb. 12, 1968

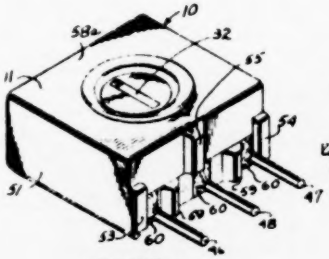


FIGURE-1

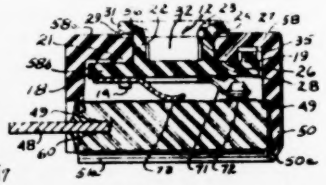


FIGURE-2

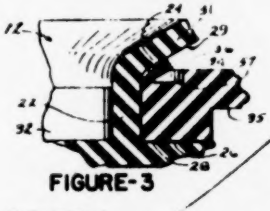


FIGURE-3

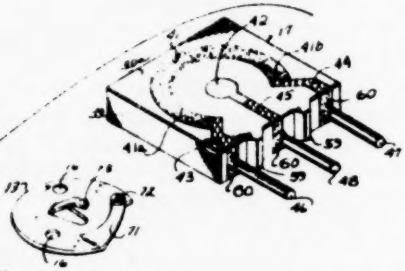
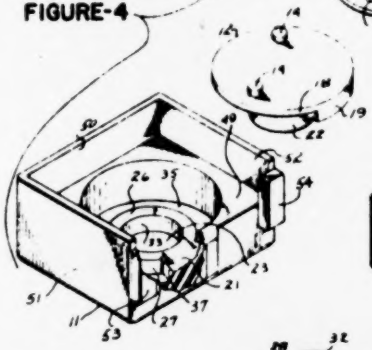


FIGURE-4



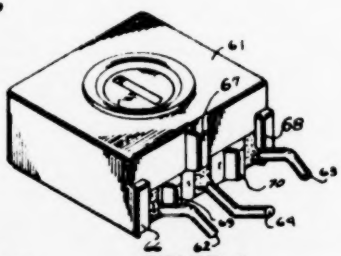


FIGURE-6

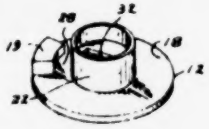


FIGURE-5

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BLURRED

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3,518,604

ELECTRICAL COMPONENT

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Int. Cl. H01c 9/02
U.S. Cl. 338—164 12 Claims

ABSTRACT OF THE DISCLOSURE

Barrel portion of a control operating means is rotatably supported in an aperture formed in a wall of a component housing. Flared portion of barrel extends around periphery of the aperture to provide sliding bearing surface thrust bearing, and dust seal. Body portion of operating means limits the degree of insertion of barrel portion in the aperture. Base abutting surfaces formed in the housing, flanges integral with the housing, and standoffs formed on a wall of the housing cooperate to precisely locate the base relative to the housing. The standoffs on the housing and standoffs on the base operate to space the component from a mounting board. Terminations anchored in the base may include snap-in mounting means for facilitating mounting of the component on a circuit board. Cementitious material may be used to improve the seal between the base and the housing of the control. Reference is made to the claims for a legal description of the invention.

The present invention relates to electrical components and, more particularly, to electrical components wherein a supporting member rotatably supports a movable control operating means in spaced relationship to a base member.

In many applications of electrical components, it is extremely important that the components be provided with means for preventing dust or other foreign matter from entering the component. Often the component is made variable so that the impedance of the component may be rather precisely and accurately adjusted. It is desirable, if not necessary, that the control operating means used to accomplish such adjustment be capable of maintaining the dust excluding integrity of the component, be easily and positively engageable manually or by a tool, and be capable of maintaining a precise setting of the component after an adjustment has been made.

Heretofore, many components have incorporated a resilient sealing member, such as a rubber O-ring, compressed between the control operating means and housing as a means for sealing the component against dust and for providing adequate rotational torque, i.e., adequate frictional resistance to changes in the setting of the component. In actual practice, however, the use of such a compressed resilient member often has not produced satisfactory results because of the tendency of the compressed member to wind up during adjustment of the component and, after a precise adjustment has been attained, the tendency of the compressed member to unwind or "springback" and alter the adjustment of the component. In addition, components using compressed resilient members have often been less than satisfactory because the compressed members have either lost their resiliency or otherwise become uncompressed with the result that the rotational torque characteristic of the component has been changed and the dust excluding integrity of the component has been compromised. In many of the components employing compressed resilient members it has also been necessary to permit the control operating means to have

two degrees of freedom of movement. For example, the control operating means has been free to rotate in order to adjust the component and has been free to move in an axial direction to compress the resilient member. This freedom to move in an axial direction has been found to cause some difficulty in precisely adjusting a component because the control operating means has sometimes moved axially in the housing when being disengaged by an adjusting tool. This movement after attainment of a rather precise setting of the component can have the undesirable effect of altering such setting.

Accordingly, it would be desirable to provide an improved electrical component wherein a movable control operating means is rotatably supported by the component housing to prevent dust from entering the housing, wherein the control operating means is easily and positively engageable for adjustment thereof, wherein the movable control operating means inherently tends to maintain settings of the component after precise adjustments thereof, and wherein the control operating means is positively restrained from moving axially within the component. It will be understood, of course, that electrical components having the aforementioned and following desirable features should be adapted for automated assembly techniques and should be at least as economical to manufacture as the components used heretofore.

It also would be desirable to provide an improved electrical component wherein the control housing is provided with base abutting surfaces for spacing the base of the component a predetermined distance from the control operating means and wherein the housing is provided with one or more flanges spaced around the base to hold the base against the base abutting surfaces so as to prevent ingress of dust into the housing around the base.

Many electrical components are frequently provided with terminations adapted to be plugged into sockets on circuit boards. Accordingly it also would be desirable to provide an electrical component with terminations having snap-in mounting means that facilitate mounting of the component on a circuit board. Yet another desirable feature would be to provide means on the housing and or base for positively spacing the component from a circuit board to facilitate flushing and cleaning between the component and circuit board. Such spacing also would accomplish the desirable result of encouraging convection current between the board and the component for dissipating heat generated during operation of the component.

Accordingly, an object of the present invention is to provide a new and improved electrical component having the various desirable features set forth above. Another object of the present invention is to provide an electrical component particularly adapted for automated assembly techniques wherein the component has a reduced number of parts thereby to permit increased economies in the manufacture of such component. Still another object of the present invention is to provide a new and improved electrical component wherein a movable control operating means prevents dust from entering the component, maintains a predetermined rotational torque during the life of the component, and is capable of being moved to effect a precise adjustment of the component while exhibiting an inherent tendency to maintain such adjustment. A further object of the present invention is to provide an easily and readily engageable movable control operating means which, when assembled with a component housing, is rotatable relative to the housing with a predetermined rotational torque and which is restrained from moving in an axial direction relative to the component. A still further object of the present invention is to provide an improved electrical component wherein means precisely space the base of the component from the control oper-

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ating means and means hold the base in assembled relation to the component in order to prevent the ingress of dust into the component around the base. A more specific object of the invention is to provide an improved electrical component having snap-in mounting means and means for positively spacing the component from a circuit board with which the component is to be ultimately used.

These objects are accomplished in accordance with one form of the present invention by providing an aperture in one wall of the housing of a variable resistance control and assembling a movable control operating means with such housing by inserting a barrel portion of the control operating means through the aperture. In order to secure the operating means to the housing and form a seal therewith, a portion of the operating means flares outwardly around the periphery of the aperture and forms a sealing bearing surface with a bearing surface of the housing while preventing withdrawal of the barrel from the aperture. A body portion of the operating means, integral with the barrel portion, limits the degree of insertion of the barrel portion in the aperture. Predetermined spacing of the base from the control operating means is attained by forming a base abutting surface or shoulder internally of the housing. A contactor, constrained to rotate with the control operating means is sealed between the operating means and the base, the latter two elements being held in fixed predetermined spacial relation by the housing after assembly. The body portion of the control operating means can optionally be disposed inside or outside the housing. The flared portion of the control operating means forms a dust seal with the housing, maintains a desirable frictional resistance to rotation of the operating means, provides a axial bearing surface while acting as a thrust bearing, and further provides a guide for the insertion of an adjusting tool when the body portion of the operating means is disposed internally of the housing. In order to space the variable resistance control from a board on which the control is to be mounted, standoffs are formed integral with the base and the housing and in a preferred embodiment, the standoffs formed on the housing provide additional means for positioning the base relative to the housing. Terminals anchored in the base are connected to resistance means and collector means supported on the base. To facilitate mounting of the control on a circuit board, the terminals may be formed to provide snap-in mounting means.

The subject matter which we regard as our invention is set forth in the appended claims. The invention itself, however, together with further objects and advantages thereof may be better understood by referring to the following descriptions taken in connection with the accompanying greatly enlarged drawings.

FIG. 1 is an isometric view of a miniature variable resistance control embodying our invention. FIG. 2 is a sectional view of the variable resistance control of FIG. 1. FIG. 3 is an enlarged view of a portion of FIG. 2. FIG. 4 is an exploded view of the variable resistance control of FIG. 1 with parts broken away, and the base rotated 180° to show the resistance path. FIG. 5 is an isometric view of movable control operating means used in the control of FIG. 1 and FIG. 6 is an isometric view of a miniature variable resistance control having snap in terminal means and embodying our invention.

Referring now more particularly to the drawings, a variable resistance control embodying one form of the invention is generally identified by the reference numeral 10. As best shown in FIGS. 2 and 4 the control 10 comprises a dust excluding housing 11, a rotatably supported control operating means in the form of a driver 12, a movable contactor 13 constrained to rotate with the driver 12 by the interaction of mutually engaging means such as the key 14 on the driver and aperture 16 in the contactor, and a base 17 sealed to the housing 11. With reference to FIGS. 2 through 5, it will be seen that the driver 12 comprises a body portion 18 carrying a snap-in mount 19 cooperable with a stationary stop 21 formed in the housing, and an integral cylindrical portion or barrel 22 extending through the aperture 23 in the housing. As best shown in FIG. 3, a distal portion of the barrel is flared outwardly over the exterior radius of the aperture 23 to form a flared bearing 24 disposed against a surface of the housing and to form a dust excluding seal around the periphery of the aperture 23. By holding the driver 12 firmly against one side of the housing, i.e., the end 26 of the skirt 27 (see FIGS. 3 and 5) while the bearing 24 is being formed against an opposite side of the housing, the driver is fully assembled with the housing 11 and any tendency for axial movement of the barrel 22 in the aperture 23 is substantially eliminated by the action of the pair of opposed bearings 24, 28 on opposed sides of the housing.

Although the barrel 22 is flared at the distal portion thereof it will be expressly understood that it is only necessary that opposed bearing surfaces internal with the driver coact with corresponding opposed bearing surfaces carried by the housing. Thus, the skirt 23 or wall of the aperture may have a continuous circular groove formed therein to provide a pair of stationary substantially opposed bearing surfaces carried by the housing and the barrel may have a distal portion in the form of a bearing ring, coacting with the bearing in the housing. It will be appreciated that when the stationary bearing is in the form of a groove between the inner and outer surfaces of the aperture a wall the flared portion on the barrel may be formed after insertion of the driver and then snapped into place in the stationary bearing. Alternately, assembly of the driver and housing may be accomplished by holding the barrel in position in the aperture and heat swaging or otherwise deforming a peripheral portion of the barrel to form a flared bearing coacting with the stationary bearing formed in the housing.

Now having reference once again to the embodiment of FIGS. 2 and 3 it will be appreciated that the flared portion of the barrel 22 is characterized by several desirable operational characteristics. More specifically, the outer surface 29 of the flared portion 31 forms a dust excluding seal with the housing, provides an annular bearing 24 for rotation of the driver 12 relative to the housing 11, creates frictional resistance to rotation of the driver 12 by reason of the friction between bearing 24 and the housing, and provides a self centering guideway for a not shown control adjusting tool when such tool is inserted in the tool receiving slot 32. The integrity of the seal, resistance to axial movement of the barrel and frictional resistance to rotation in the illustrated embodiment are attainable by reason of various structural interrelationships between the driver 12 and the housing 11. For example, the outer diameter of the barrel 22 is preferably selected relative to the inner diameter of the surface 33 of the skirt 27 to permit comparatively free rotation between the driver and housing while substantially preventing movement of the driver radially with respect to the aperture. Adequate frictional resistance to rotation is accomplished by establishing, during assembly, a predetermined pressure of engagement between the bearing 24 and a bearing surface 34 on the housing. Since the pressure of engagement may vary, as a function of among other things, the angle of inclination of the flared surface 29 relative to the axis of rotation of the driver 12, the actual interface area between the bearing surface 34 and bearing 24, and the materials used in making the driver and housing, the optimum pressure of engagement is best determined empirically after specific materials and geometrical configurations have been selected for the driver and housing. By selecting a desirable pressure of engagement between the bearing surface 34 and bearing 24 and by swaging the flared portion 31 around the periphery of the aperture 23 a desirable dust excluding seal is attained. It will also of course be appreciated that the apertured wall of the housing 11 is tightly sandwiched

between the opposed bearings 24, 28 on the driver to substantially eliminate axial movement of the driver 12 in the aperture 23. Since it is not necessary to provide a resiliently deformable sealing member, i.e. a rubber O-ring compressed between the driver 12 and housing 11, the problems associated with windup and spring back of such a member are eliminated and the driver 12 is readily and accurately adjustable in the aperture 23. The skirt 27, as shown in FIG. 4, has an inner surface 33 defining the aperture 23 and a track 35 is formed around the skirt. The stop element 19 carried by the driver is movable in the track 35 during adjustment of the control. The limits of travel of the driver 12 are defined by the ends 37 of the stationary stop 21 formed integrally with the housing 11 in the track 35.

The base 39 is formed of any suitable material but in the illustrated embodiment is formed of alumina, a high heat resistant ceramic material. Screened on the base 39 is an arcuate resistant path 41 of cermet material, a conductive center collector 42, and solderable conductors 43, 44, 45 extending between the ends 41a, 41b of the resistance elements and the terminal pins 46, 47 and between the center collector 42 and the terminal pin 48. When assembling the base assembly 17 and contactor 13 to the housing 11, the contactor 13 is positioned with the apertures 16 therein drivingly engaged by the bosses 14 on the driver 12 and the contactor 13 compressed between the body portion 18 of the driver and the base 39 as best shown in FIG. 2. The base assembly 17 is positioned in the housing 11 so that the upper surface 39a thereof engages the base abutting surface 49 of the housing. The back wall 50 and sidewalls 51, 52 of the housing cooperate with the standoffs 53, 54 for positively locating the base relative to the housing 11. Flanged distal portions of the walls retain the base against the abutting surface 49. More particularly, the walls of the housing are swaged over the base to form base-retaining flanges 50a-52a as best illustrated in FIG. 2. Although it is not a critical aspect of our invention, we have found that the addition of a cementitious material along the shoulders formed by the base abutting surface 49 of the housing prior to assembly of the base with the housing further improves the dust excluding characteristics of components embodying our invention. Cementitious materials suitable for this purpose include well known silicone adhesives which remain in a soft or semicured state.

Now having reference once more to FIG. 2, it will be seen that a lip is provided around the edge of the aperture 23 in the housing 11 to improve the dust excluding characteristics of the control. Although an adequate dust seal can be attained without providing a lip, the preferred embodiment of the invention utilizes, as illustrated, a lip in the form of a flap 56. A relieved area 57 may underlie the flap 56 so that after formation of the bearing 28 and deformation of the flap 56 around the periphery of the aperture 23 the flap may lie above the relieved area as shown in the drawing, or actually be depressed into the relieved area, depending on what pressure of engagement between the flap and bearing 24 has been selected as optimum. Of course, it will be appreciated that when the relative position of the driver and housing as viewed for example in FIG. 2 is reversed, the flap may be formed on either the side 58a of the wall 58 as shown or along the internal surface 58b of the wall 58. Although for most applications, the relative disposition of the driver and the housing illustrated in FIG. 2 is preferred, in those applications where a manually adjustable movable control operating means is desired, the body portion 18 of the driver 12 may be located externally of the housing and the barrel 22 is flared around the periphery of the aperture 23 against the internal surface 58b of the housing. With this alternative arrangement, the periphery of the body portion 18 may be knurled or otherwise contoured in order to promote facile manual adjustment thereof.

As will be best appreciated from an inspection of FIG. 1, the standoffs 53-55 formed on the housing 11 cooperate with the standoffs 59 formed on the base and space the control from a not shown mounting panel or circuit board. Such spacing is often required in order to insure that flux or solder 60 applied to the terminal pins 46, 48 during automatic soldering operations will not contact a major portion of the control. In addition, such spacing will readily permit flushing between the terminal pins after the control 10 is mounted on a circuit board and will also permit the movement of convective air currents between the control and the board. Now having reference to FIG. 6 it will be seen that control 61 illustrated therein is generally similar to the control of FIG. 1. However, the terminal pins 62, 64 have been provided with inwardly and outwardly diverging cam segments to provide snap in mounting means. With this arrangement, the component can be readily and easily snapped into place on a not shown printed circuit board with the standoffs 66, 70 spacing the control 61 from the board.

When the control illustrated in FIG. 1 was actually constructed, the base 39 was formed of high alumina having a thickness after firing of about 0.090 of an inch, a width of about 0.390 of an inch, and a depth of about 0.375 of an inch. The terminal pins 46, 48 were formed from tin coated, half hard 0.018 of an inch diameter copper wire and the conductive center collector 42 was applied to the base. The resistance path was screened onto the base and consisted of a cermet resistance material. The paddle 71 of contactor 13 was fitted with a carbon contact button 72. The paddle 73 was formed from the body of the contactor 13 as illustrated and the driver and housing were molded from a thermoplastic material. During assembly, the flared bearing 24 was formed by heat swaging as were the flanges 50a, 52a and the contactor was wedged between the driver 12 and base assembly 17 with the paddles 71, 73 resiliently engaging the resistance means 41 and collector 42, respectively. While we have shown, as an embodiment of our invention, a control having a generally rectangular configuration it will be expressly understood that generally cylindrical controls with the terminals projecting from the side or the base thereof can, with equal facility embody the present invention.

In view of the foregoing it will be appreciated that we have provided an improved electrical control having improved control operating means and having improved base and housing structural interrelationships. More specifically, the improved control operating means maintains adequate rotational torque of the control, is not shiftable axially relative to the housing, and exhibits no tendency to inherently change the control setting after adjustments thereto.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A variable resistance control comprising a dust excluding housing having a plurality of walls, a base closing the housing and forming a wall thereof, an aperture in one of the walls, a driver supported by the housing for rotation relative thereto, resistance means supported within the housing, and a contactor wipingly engaging the resistance means and constrained to rotate with the driver, the driver comprising a body portion and a barrel integral with the body portion, the barrel extending through the aperture with a portion of the barrel securing the driver to the housing, said portion of the barrel including a flared bearing extending outwardly from the periphery of the aperture.

2. The control of claim 1 wherein the housing comprises abutment means for positioning the base relative

to the housing, and at least one wall extends across a portion of the base, said at least one wall having a flange swaged over the base to secure the base to the housing.

3. The control of claim 1 wherein a plurality of terminals are supported by the base and project from a surface thereof, said base and housing having a plurality of standoffs formed thereon for spacing the control from a mounting board to be used with the control, at least one of the standoffs formed on the housing providing means for positioning the base relative to the housing.

4. The control of claim 1 wherein a collector is disposed within the housing, the contactor is wedged between the driver and the base, and the contractor is provided with first and second paddles, the first paddle wipingly engaging the collector, and the second paddle wipingly engaging the resistance means.

5. An electrical component comprising a housing having a plurality of walls, a base closing the housing and forming a wall thereof, one of said walls having an aperture therein, a control operating means rotatably supported in the aperture, resistance means supported within the housing, a contactor wipingly engaging the resistance means and constrained to move upon rotation of said control operating means, the control operating means comprising a body portion and a tool receiving portion axially alened with the aperture, said control operating means further comprising a flared portion extending around the periphery of the aperture to form a bearing support for the control operating means, to form a seal with the housing, and to facilitate insertion of a tool in the tool receiving portion.

6. A variable resistance control comprising a dust excluding housing having a plurality of walls, a base closing the housing and forming a wall thereof, an aperture in one of the walls, a driver supported by the housing for rotation relative thereto, resistance means supported within the housing, and a contactor wipingly engaging the resistance means and constrained to move upon rotation of the driver, the driver extending through the aperture with a portion of the driver securing the driver to the housing and sealing the housing around the periphery of the aperture, a sealing lip integral with said one of the walls extending around the periphery of the aperture, said sealing lip being deformed outwardly from the periphery of the aperture and being engaged by said driver to improve the seal between the housing and the driver.

7. A variable resistance control comprising a dust excluding housing having a plurality of walls, a base closing the housing and forming a wall thereof, an aperture in one of the walls, a driver supported by the housing for movement relative thereto, resistance means supported within the housing, and a contactor wipingly engaging the resistance means and constrained to move upon movement of said driver, the driver extending through the aperture with a portion of the driver securing the driver to the housing and sealing the housing around the periphery of the aperture, said portion including a flared bearing extending around the periphery of the aperture.

8. The control of claim 7 wherein a stop element is

carried by the driver and cooperates with a stationary stop projecting from said housing for limiting movement of the driver relative to the housing.

9. A variable resistance control comprising a dust excluding housing having a plurality of walls, a base closing the housing and forming a wall thereof, an aperture in one of the walls, a driver supported by the housing for rotation relative thereto, resistance means supported within the housing, and a contactor wipingly engaging the resistance means and constrained to rotate with the driver, the driver extending through the aperture with a portion of the driver securing the driver to the housing and sealing the housing around the periphery of the aperture, a skirt formed integrally with said one of the walls, an inner surface of the skirt defining the aperture, an annular track formed on a surface of said one of the walls around the skirt, the driver bearing against said skirt, a stop element carried by the driver for traveling in the annular track, and a stationary stop disposed in said track cooperating with the stop element for limiting rotation of the driver relative to the housing.

10. An electrical component comprising a housing having a plurality of walls, a base closing the housing and forming a wall thereof, an aperture in one of the walls, resistance means supported within the housing, a contactor disposed within said housing in wiping engagement with said resistance means, and a driver extending through said aperture, said driver being connected to said contactor for imparting movement to said contactor along said resistance means, a portion of said driver extending outwardly from the periphery of the aperture and forming a bearing engaging a bearing surface of said housing thereby securing the driver to the housing and sealing the housing around the periphery of the aperture.

11. The electrical component of claim 10 wherein a sealing lip extends around the periphery of the aperture and engages said driver to improve the seal between the housing and the driver.

12. The electrical component of claim 11 wherein said sealing lip is deformed outwardly from the periphery of the aperture and maintains pressure of engagement with the portion of the driver extending outwardly from the periphery.

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U.S. Cl. X.R.

338—184, 322

APPENDIX "E"

Feb. 22, 1966 W. A. BARDEN ETAL 3,237,140
VARIABLE RESISTANCE CONTROL
Filed May 20 .963 2 Sheets-Sheet 1

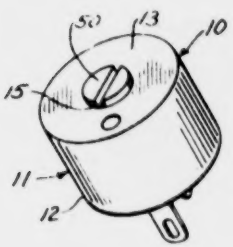

FIGURE 1.

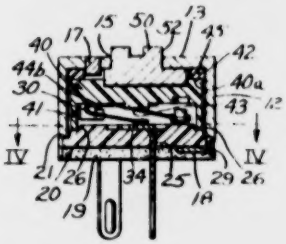

FIGURE 2

FIGURE 3.

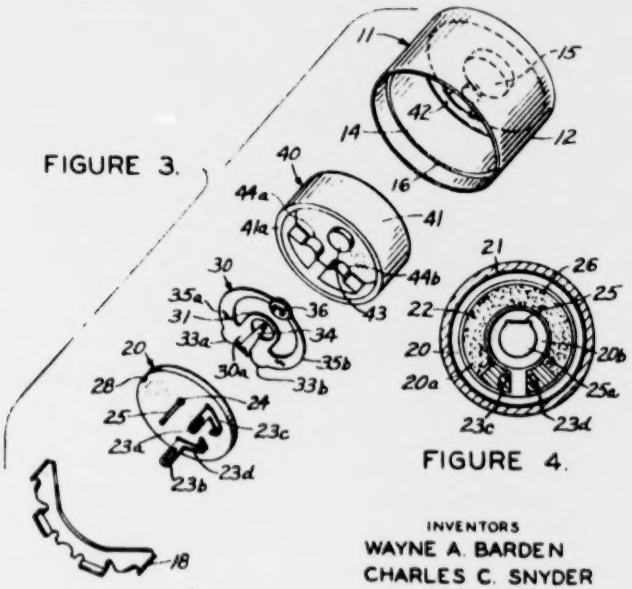

FIGURE 4.

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FIGURE 5.

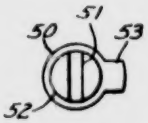

FIGURE 6.

FIGURE 7.

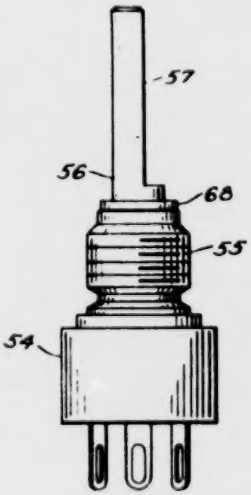

FIGURE 8.

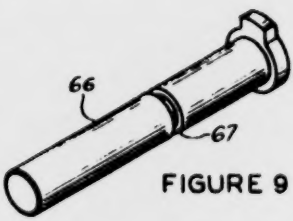

FIGURE 9

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3,237,140

Patented Feb. 22, 1966

3,237,140

VARIABLE RESISTANCE CONTROL

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Filed May 20, 1963, Ser. No. 281,405
13 Claims. (Cl. 338—164)

The present invention relates to variable resistance controls and, more particularly, to a variable resistance control having a rotatable contact assembly.

In recent years, there has been a tremendous increase in the demand for miniature variable resistance controls. By decreasing the size of the variable resistance control, other characteristics of the control, e.g., rotational torque, are also affected and generally decrease, thus increasing the possibility that the control will not maintain the same resistance setting under normal operating conditions. Initial rotational torque generally is defined as the minimum tangential force necessary to overcome static friction for rotating the shaft of the control from one resistance setting to another. Usually running torque is less than the initial rotational torque. It would be desirable, therefore, to provide a miniature variable resistance control considerably smaller than the controls heretofore available with a high rotational torque to alter the ohmic resistance thereof.

Generally, variable resistance controls are provided with a driver having a shaft molded thereto or fixedly secured thereto in a suitable manner. For economy reasons, it is desirable to mold the shaft to the driver but, in a miniature variable resistance control, the diameter of the shaft must not be reduced beyond a specific minimum dimension, otherwise the shaft probably will be sheared from the driver upon rotation of the shaft. In the past, metal shafts have been employed with variable resistance controls, however, by reducing the size of the control, difficulties regarding clearance and the strength of the connection are amplified when the shaft is fixedly secured to the driver. Clearance becomes a problem when additional space must be provided in the housing to prevent the means, e.g., tabs, securing the shaft to the driver from contacting other components in the housing or the inner surface of the housing. Since the same rotational force will be applied to the shaft regardless of the reduction in size of the control, the strength of the means securing the shaft to the driver cannot be decreased. It would be desirable, therefore, to provide a variable resistance control with a metal shaft secured to the driver in such a manner that the above mentioned problems are eliminated.

As typical of the majority of variable resistance controls, it is preferable that a stop means be employed with the control to limit rotation of the control shaft to an angle less than 360°. With a large resistance control, a mechanically sound stop means may be provided in various locations inside or outside of the housing, however, as the size of the control decreases, proportional stop means become structurally weak especially if the stop means is connected to the driver, and it becomes necessary that an enlarged stop means be employed to assure that the stop means will not be sheared off when the control shaft is rotated thereagainst. It would, therefore, also be preferable to provide a miniature variable resistance control employing stop means having the same structural strength as found in larger control units.

The mounting location of the variable resistance control unit determines the type of shaft necessary for operating the control. It would, therefore, be preferable to provide a variable resistance control with means for assembling the shaft in a simple and facile manner.

Accordingly, it is an object of the present invention to

provide a new and improved variable resistance control having the various desirable features set forth above.

Another object of the present invention is to provide a miniature variable resistance control having a high rotational torque in proportion to the size thereof.

Still another object of the present invention is to provide a variable resistance control with various types shafts.

A further object of the present invention is to provide a variable resistance control with improved stop means.

A still further object of the present invention is to provide a variable resistance control with a driver having a cavity for enclosing the contact assembly.

Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly, the variable resistance control comprises a supporting member of insulating material having an arcuate resistance film disposed on the top surface thereof. A molded cup-shaped driver having a contact assembly mounted within the cavity of the driver for rotation therewith is supported on the supporting member. The supporting member and the driver containing the contact assembly are enclosed in a housing, and rotatable means engageable from the exterior of the housing is employed for altering the angular position of the driver and the contact assembly with respect to the supporting member. As the driver is rotated, a contact button secured to the contact assembly wipes the resistance film at any desired point intermediate the ends thereof. By engaging the peripheral lip of the cup-shaped driver against the supporting member, sufficient friction is obtained therebetween. Thus the resistance setting will not change due to centrifugal forces and the like, and the employment of sufficient rotational torque is necessary to overcome and alter the wiping position of the contact button on the resistance film. Terminals are electrically connected to the ends of the arcuate resistance film and to a collector button encircled by the resistance film for electrically connecting the variable resistance control into a circuit. The driver is provided with a simple means for accomplishing any one of several shafts thereto for rotating the driver from the exterior of the housing. The shaft is secured to the driver in such a manner that no portion thereof projects into the cavity of the driver containing the contact assembly. Any one of the several shafts is provided with a lateral extension, i.e., a stop member, for engaging an inwardly extending projection such as a stop pin in the housing to limit the angular rotation of the driver.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein the same reference numerals have been applied to like parts and wherein:

FIGURE 1 is an isometric view of a variable resistance control;

FIGURE 2 is a sectional view of the variable resistance control of FIGURE 1;

FIGURE 3 is an exploded view of the variable resistance control of FIGURE 1;

FIGURE 4 is a sectional view of the control taken along line IV—IV of FIGURE 2 assuming the control is shown in full;

FIGURE 5 is a top plan view of a driver of the control;

FIGURE 6 is a top plan view of a shaft of the control;

FIGURE 7 is a side elevational view of the shaft of FIGURE 6;

FIGURE 8 is a front elevational view of another embodiment of a variable resistance control, and

FIGURE 9 is an isometric view of the shaft of a control.

Referring now to the drawings, there is illustrated a variable resistance control, generally indicated at 10, comprising a housing 11. Mounted inside of the housing are a supporting member 20, a contact assembly 30, and a driver 40 rotatably supported on the supporting member or base 20. For the purpose of rotating the driver 40, a shaft 50 operatively connected to the driver is engageable from the exterior of the housing.

Considering first the housing 11, it specifically comprises a hollow cylindrical member 12 having a centrally apertured closure wall 13 at one end thereof and open at the other end 14 thereof. Although the closure wall 13 is preferably an integral part of the housing 11, it is to be understood that the closure wall 13 may be integrally or detachably secured in a suitable manner to the hollow cylindrical member 12. The housing 11 is mounted on the supporting member 20 and is rigidly secured thereto in a suitable manner. Extending through an aperture 15 of the closure wall 13 of the housing 11 is the shaft 50 rotatable externally of the housing and operatively connected to the driver 40 supported in the housing on the supporting member 20.

As best seen in FIGURES 2 and 4 of the drawings, the supporting member 20 is provided with a circumferentially extending groove or shoulder 21 for supporting the housing 11. In the preferred form of the invention, the housing 11 is provided with a complementary circumferentially extending shoulder 16 (see FIGURE 3) engaging the groove 21 and thereby locating the supporting member 20 with respect to the inner surface of the closure wall 13 of the housing 11.

As typical of most variable resistance controls of the rotatable type, the top surface 20a (see FIGURE 4) of the supporting member 20 is provided with an arcuate resistance film 22 of carbon or cermet composition. After the arcuate resistance film 22 has been suitably secured or bonded to the top surface 20a of the supporting member 20 in a manner well known in the art, a pair of terminals 23a and 23b are secured to the supporting surface 20 with a suitable high temperature nonconductive epoxy cement. The end of each of the terminals 23a and 23b engaging the bottom surface of the supporting member 20 is provided with a lateral extension 23c and 23d respectively, each of the lateral extensions having an upended portion projecting through the supporting member 20 and communicating with the top surface 20a thereof as best seen in FIGURE 4 of the drawings. When the terminals 23a and 23b have been firmly secured to the base, a conductive film such as silver paint or other suitable conductive material is applied onto the top surface 20a of the supporting member 20 adjacent to the upended portions of the lateral extensions 23c and 23d to connect electrically the upended portion of each of the terminals to the ends of the arcuate resistance film 22.

In order to provide means for electrically connecting any point intermediate the ends of the resistance film 22 externally of the control 10, the supporting member 20 is provided with a slot 24 for receiving a center terminal 25, the terminal 25 also being bonded to the supporting member by a suitable high temperature nonconductive epoxy cement. A collector button 25a normal to the inner end of the terminal 25 and integrally connected thereto is electrically connected by means of a contact assembly 30 to any point intermediate the ends of the resistance film 22. Preferably, the top surface 20a of the supporting member 20 is provided with a recess 20b, the depth of the recess being substantially equal to the thickness of the collector button 25a so as to position the top surface thereof substantially in the same plane as the resistance film 22. Moreover, by disposing the button 25a in the recess 20b of the supporting member, the overall height of the variable resistance control 10 may be kept at a minimum.

In accord with the present invention, the supporting member 20 is provided with another circumferentially extending shoulder 26 disposed inwardly of the circumferentially extending shoulder 21 for supporting one end of the driver 40 in the housing 11. As best seen in FIGURES 2 and 4 of the drawings, the shoulders 21 and 26 of the supporting member 20 provide circuitous peripheral paths along the outer edge thereof. The driver 40 of molded construction is provided with a depending flange 41, the peripheral lip 41a thereof circumscribing the shoulder 26 of the supporting member 20. It will be appreciated that, in operation, the force exerted by the driver 40 against the supporting member 20 and the coefficient of friction determine the amount of torque necessary to rotate the driver with respect to the supporting member for altering the resistance setting of the control. For biasing the driver against the supporting member 20, a thrust washer 42 disposed inside of the housing between the top surface 40a of the driver 20 and the inner surface of the closure wall is employed. The thrust washer 42 also effectively seals the upper portion of the housing 11 and prevents moisture and the like from entering the lower inner portion of the housing. By altering the thickness of the thrust washer 42, the force exerted by the driver 40 against the supporting member may be varied.

As best seen in FIGURE 3 of the drawings, the driver 40 is provided with a downwardly extending post or boss 43 centrally located in the bottom wall of the driver 40 for supporting and centering the contact assembly 30. More specifically, the contact assembly 30 is provided with an apertured inwardly extending tongue 31, the downwardly extending boss 43 of the driver 40 being inserted in the aperture of the tongue 31 for centering the contact assembly 30. In order to assure that the contact assembly 30 is properly mounted in the driver and rotatable therewith, the inner portion of the driver 40 is provided with a pair of spaced slots 44a and 44b for receiving a pair of outwardly extending tabs 33a and 33b respectively of the contact assembly. Each of the slots is disposed between an abutment projecting inwardly of the depending flange 41 and the surface of the bottom wall of the driver 40. By mounting the outwardly extending tabs 33a and 33b of the contact assembly 30 in the slots 44a and 44b and the apertured inwardly extending tongue 31 over the downward extending post 43, the contact assembly is properly centered in the driver and rotatable therewith. The post 43 centers the contact assembly 30 and the outwardly extending tabs 33a and 33b fixedly secured in the slots constrain the contact assembly 32 to rotate with the driver. The slots 44a and 44b may be provided in the depending flange 41 of the driver. It is, however, preferable to reinforce the area adjacent to the slots with suitable abutments and cement the tabs 33a and 33b in the slots 44a and 44b.

For the purpose of electrically connecting any point intermediate the ends of the arcuate resistance film 22 to the contact button 25a integrally secured to the center terminal 25, the contact assembly 30 is provided with a resiliently bent or turned-in finger 34 extending from the base 30a thereof, the tip thereof contacting the collector button 25a (see FIGURE 2 of the drawings). The flexibility of the finger 34 is increased by connecting it at a point most remote from the center of the contact assembly 30. A pair of bifurcated arcuate arms 35a and 35b extending from the base 30a of the contact assembly toward the side diametrically opposite the base join to support a carbon contact button 36 arranged in the housing so as to wipe or ride over the arcuate resistance film 22 as the driver is rotated through a predetermined angle.

According to the present invention, the contact assembly 30, the arcuate resistance film 22, and the contact button 25a of the center terminal 25 are enclosed within

the area defined by the downwardly extending flange 41 of the driver 40 and the top surface of the supporting member 20, and, as explained above, the friction between the peripheral lip 41a of the flange 41 of the driver 40 and the supporting member 20 prevents the driver from being inadvertently rotated by centrifugal force or the like with respect to the supporting member 20. It is to be understood that a portion of the driver can frictionally engage the inner wall of the cylindrical member 12.

In the illustrated arrangement, means must be provided for rotating the driver externally of the housing. Obviously, a suitable tool, e.g., a screwdriver, can be inserted into the aperture 15 of the housing 11 for operatively engaging the top surface of the driver 40. Under such conditions, however, additional means would be necessary for rotatably supporting the end of the driver most remote from the supporting member 20. By providing the top surface of the driver 40 with a noncircular cavity 45 (see FIGURE 5 of the drawings) and by providing the end of the shaft 50 with a configuration complementary to the cavity 45, i.e., a noncircular member, the circular portion 52 of the shaft journaled in the aperture 15 of the closure wall 13 of the housing also rotatably supports the driver 40. Moreover, the end of the shaft 50 can be inserted into the cavity 45 of the driver 40 in a simple and facile manner. When the control 10 is provided with a short shaft 50, a slot 51 is inserted in the end thereof. Accordingly, the shaft 50 transfers the rotational torque applied from the exterior of the housing to the driver 40 interior of the housing and, at the same time, rotatably supports one end of the driver in the housing. By detachably securing the shaft 50 to the driver in accord with the present invention, it is possible to assemble quickly variable resistance controls with various types of external shafts and prevent foreign matter, e.g., burrs and the like, from entering the cavity of the driver enclosing the contact assembly and the resistance element.

When operating the variable resistance control 10, it is preferable that some means be employed to limit the angular rotation of the driver 40 and the contact assembly 30 mounted thereto. Otherwise, the carbon button 36 will show rapid wear when wiped over the terminal ends of the resistance element. In the preferred form of the invention, the housing 11 is provided with a stop means, e.g., a downwardly extending projection such as a stop pin 17 (see FIGURE 2) for limiting the rotation of the driver 40. As the shaft 50 is rotated, a stop member 53, as best seen in FIGURE 6 of the drawings, engages the stop pin 17 and prevents further rotation of the shaft 50 and the driver 40. Since the shaft 50 is of a hard material, for example, steel, and the stop member 53 is an integral part thereof, inadvertent excessive force will not shear the stop member 53 from the shaft 50 or the stop pin 17 from the housing 11. Moreover, since the stop member 53 is integrally connected to the shaft, the strength of the connection between the shaft and the driver is immaterial. A notch 28 (see FIGURE 3) provided in the supporting member 20 engages an inwardly extending detent 29 in the housing for orientating the member 20 with the stop pin 17. Thus the stop pin 17 always halts the angular rotation of the driver 40 when the carbon button 36 of the contact assembly 30 reaches the end of arcuate resistance film 22.

In order to maintain the supporting member 20 fixedly secured against the shoulder 16 of the housing 11, a ground plate 18 as seen in FIGURES 2 and 3 of the drawings is disposed against a portion of the bottom surface of the supporting member and the contiguous portion of the cylindrical member 12 of the housing, e.g., by welding the ground plate 18 to the housing. If it is desirable to seal the unit, a nonconductive epoxy cement 19 is poured into the cavity defined by the bottom surface of the supporting member 20 and the lower portion of the inner wall of the cylindrical member 12. In some applications, it is preferable to ground the housing to various circuit components or the like. Consequently, one or more not shown depending terminals are provided with the ground plate 18.

The embodiment seen in FIGURE 8 of the drawings is substantially the same as the embodiment of FIGURE 1, the main difference being that the housing 54 is provided with a threaded portion 55, and a shaft 56 is provided with a substantial external length for supporting a not shown control knob or the like. The internal construction of the variable resistance control seen in FIGURE 8 is identical to that seen in FIGURES 2–5 of the drawings. The shaft 56 can be provided with a flat surface 57 on the shaft may be cylindrical as shown in FIGURE 9 of the drawings. When a long shaft 66 is employed with the housing 54, the shaft 66 preferably is provided with a circumferential groove 67 for receiving a C-washer 68 in order to restrict movement of the shaft and prevent damage to the supporting member 20 and the driver 40 if an excessive axial force is applied to the shaft.

The operation of the present invention will readily be understood in view of the detailed description included above, and no further discussion is included herewith. It will be appreciated that the terminals 23a and 23b may be of wire or suitable material for electrically connecting the variable resistance control 10 into the circuit.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention and a single modification thereof, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

The invention claimed is:

1. A variable resistance control comprising a hollow cylindrical housing having a centrally apertured closure wall at one end thereof and open at the other end thereof, a driver disposed in the housing having a flange spaced from the inner surface of the cylindrical housing, a supporting member closing the open end of the cylindrical housing, the inner surface of the supporting member frictionally engaging a peripheral lip of the flange of the driver, a resistance element disposed on the supporting member, a contact assembly secured within the flange of the driver and disposed above the supporting member, the contact assembly being provided with a contact button adapted for wiping the resistance element at any desired point intermediate the ends thereof, means extending through the aperture of the closure wall and rotatable from the exterior of the housing for altering the relative position between the contactor and the resistance element, and means for connecting the control to an electrical circuit.

2. In a variable resistance control, the combination of a housing having a centrally apertured closure wall with a downwardly directed peripheral flange to define a cover open at the bottom, a supporting member closing the bottom of the housing, means for securing the member to the housing, a molded cup-shaped driver enclosed in the housing, a peripheral lip of the cup-shaped driver slidably engaging the supporting member, a contact assembly disposed within the cup shaped driver, a resistance element mounted onto a surface of the supporting member, said contact assembly including a contact adapted for wiping the resistance element at any desired point intermediate the ends thereof, and means extending through the apertured closure wall of the housing and operatively connected to the driver for rotating the driver and the contact mounted therein.

3. In variable resistance unit, the combination of a housing having a depending flange and open at the bottom, a base closing the bottom of the housing, a resistance film bonded to a surface of the base, a cup-shaped driver rotatably supported on the base, a peripheral lip extend-

ing from the cup-shaped driver slidably engaging the base, means electrically connecting the resistance film to the exterior of the housing, a contact assembly fixedly secured to the cup-shaped driver and a rotatable means extending through an aperture in the housing and engageable with means provided in the bottom wall of the cup-shaped driver whereby rotation of the rotatable means wipes a contact button of the contact assembly across the resistance film intermediate the ends thereof.

4. An electrical control comprising, a hollow cylindrical housing having a closed end and an open end, the closed end being provided with an aperture, a base mounted in the open end of the cylindrical housing, a cup-shaped driver rotatably supported on the base, a resistance element fixedly mounted to the base, a contact assembly mounted in the cup-shaped driver and including a contact button adapted for wiping the resistance element at any desired point intermediate the ends thereof, and a shaft extending through the aperture of the housing for rotating the driver, a noncircular member attached to the shaft, the top surface of said cup-shaped driver being provided with a noncircular cavity having disposed therein the noncircular member attached to the shaft, the other end of the shaft extending through the aperture in the cylindrical housing whereby rotation of the shaft alters the position of the driver and the position of the contact button on the resistance element.

5. A contact assembly for a variable resistance control having a driver, a collector button, and a resistance element, the contact assembly comprising a base, a tongue extending from the base and provided with an opening for centering the contact assembly on the driver of the control, a pair of spaced tabs depending from the base for fixedly securing the angular position of the contact assembly with respect to the driver, a resilient bent finger connected to the base for engaging the collector button of the variable resistance control, and a pair of bifurcated arcuate arms extending from the base to a point diametrically opposite the base, the distal ends of the arcuate arms being joined to each other to provide means for supporting a carbon contact button, the carbon contact button being adapted to wipe the resistance element disposed in the control.

6. A driver for a variable resistance control having a supporting member, a resistance element carried by the supporting member, a contact assembly provided with a pair of tabs and engaging the resistance element, and a shaft, the driver comprising a circular member having a top surface and a bottom surface, the top surface of the circular member being provided with a cavity for receiving the distal end of the shaft, a boss secured to the bottom surface for centering the contact assembly of the control, and a circular flange integrally secured to the circular member and having a peripheral lip in frictional engagement with the supporting member of the control, the flange being provided with a pair of spaced slots for receiving the pair of tabs of the contact assembly to restrict the assembly with the driver.

7. In a variable resistance unit, the combination of a base having a circumferentially extending shoulder, a resistance element disposed on said base, a cup-shaped driver having a downwardly directed flange, the lip portion thereof being in frictional engagement with the circumferentially extending shoulder on the base, a contact assembly mounted in the cavity of the driver for electrically wiping a button across the resistance element, a hollow cylindrical housing enclosing the driver and supported on the base, the housing having an end wall provided with a centrally located aperture, and rotatable means extending through the aperture and engageable with a cavity communicating with the top surface of the driver.

8. An electrical control comprising a housing provided with spaced apart front and rear walls, one of the walls being provided with an aperture, a driver having a bearing surface, the bearing surface being in frictional engagement with the inner surface of one of the walls of the housing, an annular ring of resilient material intermediate one of the walls of the housing and the driver for biasing the driver against the other wall of the housing, a contact assembly fixedly secured to the driver, means for making an electrical connection to the contact assembly, a resistance element disposed in the housing intermediate the walls thereof and electrically connected to a pair of terminals extending from the housing, a contact button mounted on the contact assembly and adapted for wiping the resistance element at any desired point intermediate the ends thereof, and means extending through the aperture and rotatable from the exterior of the housing for altering the relative position between the contact button and one end of the resistance element.

9. In a variable resistance unit, the combination of a supporting member provided with a supporting surface, an arcuate resistance means secured to the supporting surface, a cup shaped driver supported by the supporting surface, a collector button centrally located and fixedly secured to the supporting member, a contact assembly fixedly secured within a cavity of the cup-shaped driver and including a contact button for wiping the resistance means at any desired point intermediate the ends thereof and a finger in electrical contact with the collector button, a hollow cylindrical housing provided with a centrally apertured closure wall at one end thereof and open at the other end thereof for receiving the cup-shaped driver and the supporting member, resilient means disposed between the inner surface of the closure wall of the housing and the cup-shaped driver for biasing the driver against the supporting surface, means for fixedly securing the supporting surface within the housing, and means operatively connected to the inner surface of the driver and extending from the exterior of the housing for rotating the cup-shaped driver and the contact assembly through a predetermined angle.

10. In a variable resistance control, the combination of a housing provided with an apertured end wall, a supporting member mounted in one end of the housing in spaced relationship to the apertured end wall, a circumferential shoulder extending inwardly of the supporting member and integrally connected thereto, a driver disposed in the housing intermediate the end wall and the supporting member and having one end rotatably journaled on the circumferential shoulder, a detachably secured shaft journaled in the apertured end wall of the housing and rotatably supporting the other end of the driver, and means mounted to the driver for wiping a contact button intermediate the ends of a resistance element disposed in the housing, the means mounted to the driver being completely isolated from the end of the shaft.

11. In a variable resistance control, the combination of a housing provided with an apertured end wall, a supporting member mounted in one end of the housing in spaced relationship to the apertured end wall, a circumferential shoulder extending inwardly of the supporting member and integrally connected thereto, a driver disposed in the housing intermediate the end wall and the supporting member and having one end rotatably journaled on the circumferential shoulder, a shaft journaled in the apertured end wall of the housing and rotatably supporting the other end of the driver, a resistance element adhered to the supporting member and encircled by the circumferential shoulder, and a bifurcated contact assembly mounted to the driver and supporting a contact button for wiping the resistance element intermediate the ends thereof.

12. In a variable resistance unit, the combination of a hollow cylindrical housing closed at one end and open at the other end, a base member closing the open end of the housing, the housing being provided with a centrally located aperture, a resistance element disposed in the housing, a driver mounted in the housing, a contact assembly constrained to rotate with the driver, a shaft journaled in

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the centrally located aperture, a stop pin, and a lateral extension integral with the shaft defining a stop member engageable with the stop pin for limiting rotation of the shaft to an angle of less than 360°, a portion of the lateral extension and of the shaft being disposed in a mating cavity provided in the driver constraining the driver to rotate with the shaft.

13. A variable resistance unit comprising a hollow housing having an apertured closure wall and a depending flange to define a cover open at the bottom, a driver disposed in the housing, a supporting member received by the bottom opening of the housing, a resistance element secured to the inner surface of the supporting member, a contact assembly secured to the driver and rotatable therewith for wiping a contact button along the resistance element intermediate the ends thereof, a shaft extending through the aperture, a stop pin, and a lateral extension integral with the shaft defining a stop member engageable with the stop pin for limiting rotation of the shaft to an angle of less than 360°, the lower portion of the lateral

extension and of the shaft being disposed in a mating cavity provided in the driver constraining the driver to rotate with the shaft.

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APPENDIX "F"

March 26, 1968 J. VAN BENTHUYSEN ET AL 3,375,478

ELECTRICAL CONTROL AND METHOD OF MAKING THE SAME

Filed May 11, 1964 2 Sheets-Sheet 1

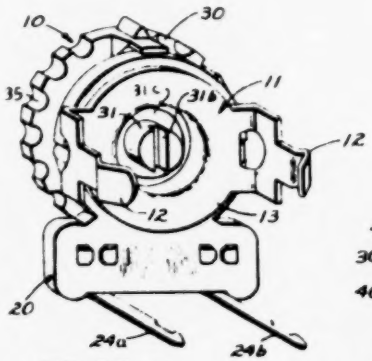

FIGURE 1.

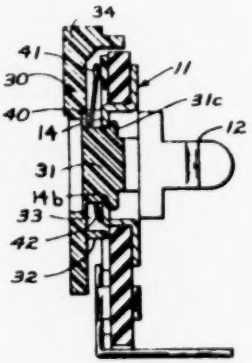

FIGURE 3.

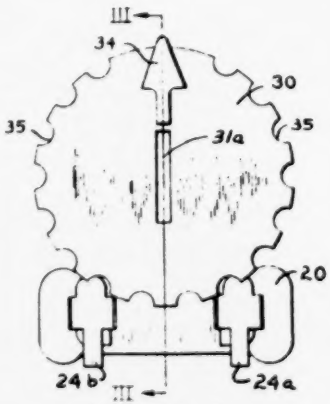

FIGURE 2.

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March 26, 1968 J. VAN BENTHUYSEN ET AL 3,375,478
ELECTRICAL CONTROL AND METHOD OF MAKING THE SAME
Filed May 11, 1964 2 Sheets-Sheet

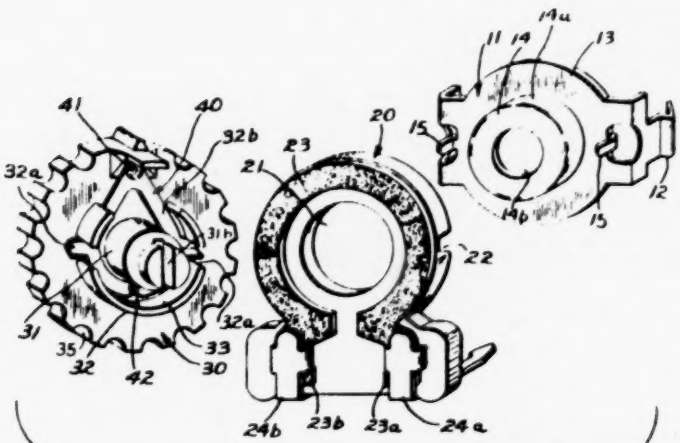

FIGURE 4.

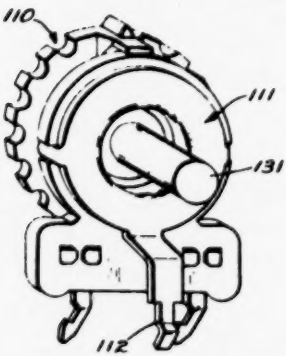

FIGURE 6.

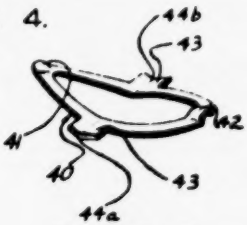

FIGURE 5.

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United States Patent Office 3,375,478 Patented Mar. 26, 1968

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ELECTRICAL CONTROL AND METHOD OF MAKING THE SAME

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10 Claims. (Cl. 338—174)

ABSTRACT OF THE DISCLOSURE

A variable resistance control having a resistance element supported on an electrically conductive bracket integral with a collector ring. A rotatable member is rotatably secured to the bracket with an electrically nonconductive heat-deformable shaft. The portion of the shaft journaled in an aperture provided in the bracket is swaged to increase the diameter and improve the bearing fit between the shaft and the bracket. An annular ring integral with the rotatable member slideably engages the resistance element for stabilizing the rotatable member relative to the resistance element and an equalizing contactor pivotally supported by a pair of arms is resiliently disposed in the space between the shaft and the annular ring.

The present invention relates to electrical controls, and, more particularly, to a variable resistance control of the type provided with a rotatable contactor and to a method of making the same.

Many of the variable resistance controls presently manufactured must meet many design and test requirements, for example, the shaft must be rotatable in a substantially wobbleless manner, and the fluid or lubricant in the bearing must not impose a substantial load upon the shaft at abnormal temperatures or flow out of the bearing at elevated temperatures. It is well known that several materials such as nylon are excellent bearing-forming materials since these materials need not be lubricated with a fluid. Consequently many shafts whether of brass, steel or the like are journaled in nylon bearings. Such construction, however, requires that the shafts usually be machined in order that the proper bearing fit be maintained. In recent years, the cost of some variable resistance controls has been decreased by making the shafts of an electrically nonconductive material such as nylon. An example of a nylon shaft construction is shown in the Zunker et al. Patent No. 3,032,734, dated May 1, 1962. Although the variable resistance controls with nylon shafts are primarily employed in equipment not requiring controls having close bearing fits, these controls would be further accepted and in greater demand if the bearing fit could be improved without substantially increasing the cost of the control. It would, therefore, be desirable to provide a variable resistance control having a nylon shaft closely fitted in a bearing.

Whenever the shaft rotatably supporting the contactor is closely fitted in the bearing of the variable resistance control, many problems, e.g., wobbleness, occur. These problems become of greater concern as the size and the cost of the control are decreased. It would, therefore, be desirable to provide a method for properly fitting the shaft in the bearing during assembly and for preventing wobbleness of the rotatable member of the variable resistance control.

One of the most difficult requirements to obtain with a decrease in size of a variable resistance control is to maintain the proper rotational torque. Thrust washers and the like generally become ineffective because the washers are provided with standard manufacturing tolerances. Therefore, whenever a nylon shaft has been used in the manufacture of a variable resistance control, the method of obtaining the proper rotational torque has been accomplished in the same manner as with metal shafts. It would, therefore, be desirable to provide improved means for maintaining the proper rotational torque by prestressing the nylon shaft during the process of assembling the variable resistance control.

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The conventional variable resistance control generally employs a rotatable contactor fixedly secured to the rotatable member, i.e., the driver. As the size of the control decreases, greater problems also are encountered in constraining the contactor to rotate with the driver. Moreover, the deviation in contact pressure of the contactor varies inversely with the size of the contactor since the contactor as well as the other parts of the control are made with standard manufacturing tolerances to maintain cost at a minimum. Thus there is a tendency for a greater differential in contact pressures to exist against the resistance element and the collector ring. It would, therefore, also be desirable to provide a variable resistance control with improved means for constraining the contactor to rotate with the driver as well as employ a contactor having means for equalizing the contact pressures in a preset ratio against the resistance element and the collector ring.

Accordingly, it is an object of the present invention to provide a new and improved variable resistance control having the various desirable features set forth above.

Another object of the present invention is to provide a variable resistance control with a shaft of an electrically nonconductive heat-deformable material, the end thereof being swaged to secure the shaft to the mounting bracket and to increase the diameter of the shaft in the bearing supporting the shaft.

An additional object of the present invention is to provide a variable resistance control of simple and compact structure with a rotatable member having an integral shaft rotatable in a bearing and an additional annular bearing equally spaced from the shaft and disposed within an arcuate resistance element for eliminating the wobbleness of the rotatable member as it is rotated.

A further object of the present invention is to provide a variable resistance control wherein the inner periphery of the collector ring functions as a bearing for rotatably supporting a shaft and the outer periphery of the collector ring aligns the base of the control supporting the arcuate resistance element in concentric relationship with the shaft.

Still another object of the present invention is to provide a variable resistance control with an arcuate cavity in the inner surface of the rotatable member for resiliently supporting a contactor and for constraining the contactor to rotate with the rotatable member.

Yet another object of the present invention is to provide a variable resistance control with a collector ring integrally connected to and embossed from a mounting bracket.

A still further object of the present invention is to provide a variable resistance control of simple and compact structure embodying a contactor provided with a pair of diametrically opposed pivotal arms for equalizing the contact pressures in a preset ratio applied by the contacts of the contactor against the arcuate resistance element and the collector ring.

Still an additional object of the present invention is to provide a method of providing the proper rotational torque and a method of improving the fit between a bearing and the shaft rotatable therein when assembling the variable resistance control.

Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty characterizing the

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invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly, the present invention is concerned with a variable resistance control comprising an electrically nonconductive heat-deformable shaft, e.g., of nylon, supported by a mounting bracket provided with an embossed annular member or collector ring having an apertured center portion. A base having an arcuate resistance element fixedly secured thereto with a pair of terminals securing the ends of the arcuate resistance element to the base is also provided with a centrally disposed opening, the inner edge thereof cooperating with the outer periphery of the collector ring for aligning the collector ring in concentric relationship with the arcuate resistance element. Suitable tabs are provided between the base and the mounting bracket for preventing rotation therebetween. A rotatable member of electrically nonconductive heat-deformable material, such as nylon, is integrally secured to the shaft, and an annular ring spaced from the shaft provides an arcuate cavity nestedly supporting a contactor. The contactor received in the arcuate cavity is provided with a pair of diametrically opposed pivotal arms, and on opposite sides of the pair of pivotal arms is a pair of contacts, one of the contacts engaging the collector ring and the other contact engaging the arcuate resistance element. Thus, an increase in force upon one of the contacts of the contactor automatically increases the force upon the other contactor in a preset ratio thereby equalizing the forces applied thereagainst.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein the same reference numerals have been applied to like parts and wherein:

FIGURE 1 is an isometric rear view of an improved variable resistance control built in accord with the present invention;

FIGURE 2 is a front view of the variable resistance control shown in FIGURE 1;

FIGURE 3 is a cross sectional view of the variable resistance control taken along lines III—III of FIGURE 2;

FIGURE 4 is an exploded view of the variable resistance control shown in FIGURE 1;

FIGURE 5 is an isometric view of the equalizing contactor for the variable resistance control of the present invention; and

FIGURE 6 is another embodiment of a variable resistance control of the present invention.

Referring now to the drawings, there is illustrated a variable resistance control, generally indicated at **10**, comprising a mounting bracket **11**, a base **20**, an electrically nonconducting heat-deformable rotatable member **30**, and an equalizing contactor **40**.

Considering first the mounting bracket **11**, as best seen in FIGURES 1 and 4 of the drawings, it preferably comprises a one piece sheet metal stamping having a pair of snap-in fingers **12** extending rearwardly from a flat center portion **13** for quickly mounting and electrically connecting a portion of the variable resistance control **10** to a panel or the like. A collector ring **14** is embossed from the flat center portion **13** and extends inwardly thereof, the outer periphery **14***a* of the collector ring being positioned in an opening **21** of the base **20** for aligning the base **20** in concentric relationship with the collector ring **14**. The collector ring **14** preferably projects into the opening **21** slightly greater than the thickness of the base **20** (see FIGURE 3). It is to be understood, however, that the depth of projection is not critical so long as the collector ring **14** is centered in the opening **21** by the outer periphery **14***a*.

For the purpose of preventing relative rotation between the base **20** and the mounting bracket **11**, a pair of inwardly extending tabs **15** are disposed on opposite sides of the flat center portion **13** and engage notches **22** in the base. The tabs **15** are integral with the mounting bracket and preferably are punched out of the flat center portion **13** thereof.

As best illustrated in FIGURE 4 of the drawings, an arcuate resistance element **23** provided with a pair of depending legs **23***a* and **23***b* is fixedly mounted to the base **20** with a pair of terminals **24***a* and **24***b* in a suitable manner well known in the art. When the resistance element is of a carbon composition, the base generally is punched from an electrically nonconductive material such as laminated plastic; however, a base or substrate of ceramic material may be employed whenever higher temperature resistance elements are preferred and the rotatable member **30** may be journaled in an aperture in the substrate. The ends of the terminals **24***a* and **24***b* may extend rearwardly of the base as shown in FIGURES 1, 3 and 4 of the drawings, the disposition thereof depending upon the location of the mounting panel.

In a device built in accord with the present invention, the rotatable member **30** preferably is molded of an electrically nonconductive heat-deformable material such as nylon. For rotatably supporting the member **30** with respect to the base **20**, a shaft or spindle **31** extends inwardly of the rotatable member **30** and is journaled in the aperture **14***b* provided in the collector ring **14**. With the above-described arrangement, the rotatable member **30** is readily assembled to the mounting bracket **11** by merely inserting the end of the shaft **31** into the aperture **14***b* of the collector ring **14** and heat swaging the end of the shaft projecting outwardly from the collector ring **14** as shown in FIGURES 1 and 3 of the drawings. Thus the collector ring **14** not only rotatably supports the shaft **31** extending inwardly from the rotatable member **30** but also centers the base **20** and the resistance element **23** with respect to the rotatable member **30**. A suitable heated cylindrical tool having an apertured bore is employed for swaging the outer periphery of the shaft against the rear surface of the collector ring to form an enlarged portion **31***c*, and simultaneously the swaging operation increases the diameter of the shaft disposed in the aperture **14***b* of the collector ring **14**. Such design assures a tight bearing fit between the shaft **31** and the bearing or aperture **14***b* as well as eliminating longitudinal movement of the shaft. Whenever the control **10** is adjusted frequently, the inner edge of the collector ring defining the aperture **14***b*, is widened to increase the surface area of the bearing.

It will be appreciated that as the size of the control is decreased greater problems are encountered in securing the contactor to the rotatable member **30** and in constraining the contactor **40** to rotate with the rotatable member **30**. The arrangement for accomplishing this will be described in detail hereinafter. As best shown in FIGURE 4 of the drawings, extending rearwardly from the inner surface of the rotatable member **30** is an arcuate member or annular ring **32** integral with the member **30**, the outer edge or peripheral lip of the annular ring **32** engaging the portion of the base **20** (see FIGURE 3) adjacent to and circumposing the outer periphery of the collector ring **14**. The variable resistance control **10** is thereby provided with two bearing surfaces, the first bearing surface being the surface of the aperture **14***b* supporting the shaft **31** and the second bearing surface being the outer edge of the annular ring **32**. The first bearing surface aligns the contactor **40** with the resistance element **23** and the collector ring **14** when the rotatable member **30** is rotated with respect to the base **20**, and the second bearing surface stabilizes the rotatable member **30** and thus prevents wobbleness when the rotatable member is rotated.

Preferably and as illustrated in FIGURE 4 of the drawings, the contactor **40** having a pair of contacts **41** and **42** is nestedly received in an annular cavity **33** formed by the shaft **31** and the inner surface of the annular ring **32**. The contact **41** is disposed a greater distance from the axis of the shaft **31** than the contact **42** of the con-

tactor 40 for making electrical engagement with the arcuate resistance element 23 and the contact 42 engages the collector ring 14. The distance from the contacts 41 and 42 to the axis of the shaft also determines the ratio of the contact pressures. To constrain the contactor 40 to rotate with the rotatable member 30, the annular ring 32 is provided with a pair of slots 32a receiving a pair of outwardly extending diametrically opposite arms 43 integrally connected to the contactor 40. The annular ring 32 is also provided with a slot 32b for receiving the portion of the contactor 40 carrying the contact 41. The arms 43 of the contactor 40 are preformed into a V cross-section by forming a crease extending through both arms as shown in FIGURE 5 of the drawings, and the bottom edge of the V forms pivot edges 44a and 44b for pivotal movement of the contactor. Therefore, any manufacturing tolerances resulting in the angle that the contactor is creased or should any differences in tolerances or thickness occur so as to vary the dimension between the top surface of the collector ring and the arcuate resistance element, the contact pressures thereagainst will be balanced in a preset ratio since the contactor 40 will merely pivot on pivot edges 44a and 44b.

From the above description it is apparent that the variable resistance control 10 can be rapidly assembled in production. For example, the rotatable member 30 is carried by a movable supporting surface and a contactor 40 is automatically assembled to the rotatable member 30 by merely dropping the contactor 40 over the shaft 31 with the arms 43 of the contactor in alignment with the slots 32a. The mounting bracket 11 is then assembled to the base 20 with the arcuate resistance element 23 facing the rotatable member 30. After the base 20 and mounting bracket 11 are assembled in position on the shaft 31, it is merely necessary to compress the parts together and heat swage the outer peripheral portion of the shaft to secure the mounting bracket to the rotatable member 30. By heat swaging only the outer periphery of the shaft as shown in FIGURES 1 and 3, the rotatable member may still be rotated by inserting a tool in the slot 31b provided in the distal end of the shaft. Simultaneously, during the heat swaging operation, the force of the heat swaging tool increases the diameter of the shaft within the aperture 14b for improving the fit between the shaft and the bearing. Whenever it is desired to increase the rotational torque of the variable resistance control 10, it is merely necessary to provide a button or raised portion in the center of the surface supporting the rotatable member 30 for urging the shaft 31 further into the aperture 14b of the collector ring 14. Since the button engages only the center portion of the rotatable member 30, the peripheral edge of the rotatable member 30 is forced downwardly due to the pivotal action of the annular ring 32 and forms the rotatable member 30 into a dished or concave construction encircling the button, such construction developing a prestressed condition in the shaft after final assembly. By controlling the thickness of the button, the rotational torque may be readily controlled. After the enlarged portion 31c of the shaft 31 cools sufficiently, the force compressing the parts together is released.

In order that the variable resistance control 10 can be rotated from either the front or rear thereof, a slot 31a (see FIGURE 2) is provided on the front surface thereof in addition to the slot 31b provided in the rear end of the shaft (see FIGURES 1 and 4). An arrow 34 is provided on the front face of the rotatable member 30 to indicate the angular position of the contactor, i.e., to indicate the amount of resistance in or out of the circuit. A plurality of undulations 35 is provided in the periphery of the rotatable member to facilitate rotation thereof without a tool.

An additional embodiment of the invention is shown in FIGURE 6 of the drawings, the variable resistance control 110 being substantially the same as the variable resistance control 10 shown in FIGURES 1-4 of the drawings. The main difference is that the shaft 131 extends rearwardly sufficiently so as to provide means for securing a knob or the like to the shaft of the control. Further, the mounting bracket 111 is provided with a depending terminal 112 instead of a pair of rearwardly extending terminals for mounting the variable resistor to a horizontally disposed mounting plate instead of a vertically disposed mounting plate.

While there has been illustrated and described what is at present considered to a preferred embodiment of the present invention, a single modification thereof, and a method of making the same, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A variable resistance control comprising an electrically conductive mounting bracket, a collector ring embossed from the plane of the mounting bracket and provided with an aperture, an electrically nonconductive heat deformable shaft rotatably journaled in the aperture, an electrically nonconductive rotatable member integrally secured to the shaft in spaced relationship to the mounting bracket, an electrically nonconductive base carried by the mounting bracket and disposed between the mounting bracket and the rotatable member, an arcuate member extending partially around the shaft and spaced from the shaft, said arcuate member being integral with the rotatable member and having a peripheral lip slideably engaging the base for stabilizing the rotatable member, the shaft and the arcuate member defining a space therebetween, an arcuate resistance element mounted on the base concentric to the collector ring, and an equalizing contactor resiliently disposed in the space between the shaft and the arcuate member and constrained to rotate with the rotatable member, the contactor having a first contact button engaging the resistance element intermediate the ends thereof and a second contact button engaging the collector ring for electrically connecting the resistance element to the mounting bracket as the rotatable member is rotated.

2. In a variable resistance control, the combination of an electrically conductive mounting bracket having an aperture, a collector ring integrally secured to the mounting bracket and having a top surface, an electrically nonconductive apertured base supported by the mounting bracket, and having therein an aperture in axial alignment with the aperture in the mounting bracket, the area of the aperture in the base being greater than the area of the top surface of the collector ring so that the collector ring and mounting bracket can be assembled from one side of the base, the mounting bracket having a flat portion facing said one side of the base, the collector ring being disposed in axial alignment with the aperture of the base, an arcuate resistance element carried by the other side of the base in concentric relationship to the collector ring, an electrically nonconductive shaft rotatably supported in the aperture of the mounting bracket, an electrically nonconductive rotatable member integrally secured to the shaft in spaced relationship to the base, an electrically nonconductive means integrally secured to the rotatable member around the shaft for spacing the rotatable member from the base, and a contactor interposed between the rotatable member and the base and constrained to rotate with the member for wiping the collector ring and the resistance element intermediate the ends thereof.

3. In a variable resistance control, the combination of a mounting bracket having a flat center portion, a collector ring integral with and embossed from the flat center portion of the mounting bracket, an electrically nonconductive base provided with an aperture, the flat central por-

tion of the mounting bracket having a portion thereof extending around the aperture in the base and engaging one side of the base, the collector ring projecting from the portion of the bracket engaging one side of the base into the aperture in the base at least the thickness of the base, an arcuate resistance element carried by the other side of the base in spaced concentric relationship to the collector ring, a rotatable member provided with an arcuate cavity opening toward the collector ring, said bracket being provided with an aperture, a heat-deformable shaft received in the aperture in the bracket connecting the rotatable member to the mounting bracket, and an equalizing contactor nested in the arcuate cavity and constrained to rotate with the rotatable member, the equalizing contactor having a first contact button engaging the resistance element intermediate the ends thereof and a second contact button engaging the collector ring for electrically connecting the resistance element to the mounting bracket as the rotatable member is rotated.

4. A variable resistance control comprising a mounting bracket, an apertured collector ring integral with the mounting bracket and embossed from the center portion of the mounting bracket, an electrically nonconductive base supported by the mounting bracket, the collector ring projecting into an opening provided in the base, a resistance element carried by the base in spaced relationship to the collector ring, a rotatable member, an electrically nonconductive shaft of heat deformable material connected to the rotatable member and rotatably journaled in the aperture of the collector ring, the portion of the shaft extending beyond the aperture being enlarged and rotatably securing the shaft to the mounting bracket, the portion of the shaft in the aperture being enlarged to improve the fit of the shaft in the aperture, and a contactor carried by the rotatable member for wiping the collector ring and the resistance element intermediate the ends thereof.

5. A variable resistance control comprising a mounting bracket, an electrically nonconductive base supported by the mounting bracket, a resistance element carried by the base, a rotatable member, an electrically nonconductive shaft of heat-deformable material connected to the rotatable member and rotatably journaled in an aperture provided in the mounting bracket, the portion of the shaft extending beyond the aperture being enlarged and rotatably securing the shaft to the mounting bracket, the portion of the shaft in the aperture being of a slightly larger diameter than the portion of the shaft connected to the rotatable member to improve the fit of the shaft in the aperture, a collector ring carried by the base, and a contactor carried by the rotatable member for wiping the collector ring and the resistance element intermediate the ends thereof.

6. A variable resistance control comprising an apertured base, a resistance element carried by the base, a collector ring carried by the base, a rotatable member, an electrically nonconductive shaft of heat-deformable material connected to the rotatable member and rotatably journaled in an aperture provided in the base, the portion of the shaft extending beyond the aperture being enlarged and rotatably securing the shaft to the base, the portion of the shaft in the aperture being of a slightly larger diameter than the portion of the shaft connected to the rotatable member to improve the fit of the shaft in the aperture, and a contactor carried by the rotatable member for wiping the collector ring and the resistance element intermediate the ends thereof.

7. A variable resistance control comprising a mounting bracket, a collector ring integral with the mounting bracket and projecting from the center portion thereof, an electrically nonconductive base supported by the mounting bracket, the base being provided with an opening receiving the collector ring, means for preventing relative rotation between the mounting bracket and the electrically nonconductive base, a resistance element mounted on the base in concentric relationship to the collector ring, a rotatable member, a shaft of heat deformable material integral with the rotatable member, the end portion of the shaft being journaled in an aperture provided in the collector ring, the end portion of the shaft extending beyond the aperture being enlarged to connect the shaft to the mounting bracket, the rotatable member being provided with an arcuate cavity opening toward the collector ring, an equalizing contactor nested in the arcuate cavity and constrained to rotate with the rotatable member, the equalizing contactor having a pair of opposite ends and a pair of arms integral with the contactor and extending outwardly thereof for pivotally supporting the opposite ends of the contactor, the one end of the contactor having a first contact button engaging the resistance element intermediate the ends thereof and the other end of the contactor having a second contact button engaging the collector ring for electrically connecting the resistance element to the mounting bracket as the rotatable member is rotated.

8. A variable resistance control comprising a combination mounting bracket and collector ring, the collector ring being embossed from the center portion of the mounting bracket, an electrically nonconductive base supported by the combination mounting bracket and collector ring, the collector ring being disposed in an aperture provided in the electrically nonconductive base and projecting inwardly of the base, an arcuate resistance element mounted on the base in concentric relationship to the collector ring, an electrically nonconductive heat-deformable rotatable member, means securing the rotatable member to the combination mounting bracket and collector ring, and an equalizing contactor carried by the rotatable member and constrained to rotate therewith, the contactor comprising a pair of outwardly extending preformed arms, each arm having a pivotal edge engaging the inner surface of the rotatable member, the contactor having a first contact button engaging the resistance element intermediate the ends thereof and a second contact button engaging the collector ring for electrically connecting the resistance element to the combination mounting bracket and the collector ring as the rotatable member is rotated, the contactor being adapted to pivot on the pivotal edges for equalizing the contact pressures in a preset ratio against the resistance element and the collector ring as the contactor is constrained to rotate with the rotatable member.

9. In a variable resistance control, the combination of a mounting bracket having a flat portion, a collector ring integral with the flat portion of the mounting bracket, an electrically nonconductive base provided with an aperture, the flat portion of the mounting bracket engaging one side of the base and the collector ring projecting into the aperture at least the thickness of the base, an arcuate resistance element carried by the other side of the base in spaced concentric relationship to the collector ring, a rotatable member provided with an arcuate cavity opening toward the collector ring, a shaft connecting the rotatable member to the mounting bracket, the end portion of the shaft being disposed in an aperture of the collector ring, the end portion of the shaft extending beyond the aperture of the collector ring being enlarged to maintain the shaft assembled to the mounting bracket, the portion of the shaft in the aperture of the collector ring being enlarged to decrease the tolerance between the shaft and the bearing, and a contactor nested in the arcuate cavity and constrained to rotate with the rotatable member, the contactor having a first contact button engaging the resistance element intermediate the ends thereof and a second contact button engaging the collector ring for electrically connecting the resistance element to the mounting bracket as the rotatable member is rotated.

10. In a variable resistance control, the combination of an electrically conductive mounting bracket, a snap-in finger integral with the mounting bracket for positioning

the control at a definite distance from a panel, said snap-in finger being provided with a lateral abutment adapted to seat upon a panel, said snap-in finger being adapted for detent-like engagement in a hole provided in the panel upon which the abutment seats, a collector of a predetermined size integral with the mounting bracket, said collector having a top surface and provided with a bearing, an electrically nonconductive base carried by the mounting bracket and having one side of the base facing the mounting bracket, one side of the base facing the mounting bracket, the nonconductive base having an aperture therein, the area of the aperture in the base being greater than the area of the top surface of the collector so that the collector and mounting bracket can be assembled to the base from one side of the base, an arcuate resistance element secured on the other side of the base circumposing the collector, a contactor engaging the resistance element and the collector for electrically connecting the resistance element to the mounting bracket, and rotatable means supported in the bearing, said contactor being constructed to rotate with said means for wiping the element intermediate the ends thereof.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,375,478 March 26, 1968

John Van Benthuysen et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 57, strike out "at", first occurrence; column 4, line 45, after "14b" strike out the comma; column 6, line 50, strike out "apertured"; column 9, lines 10 and 11, strike out "one side of the base facing the mounting bracket,".

Signed and sealed this 29th day of July 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

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Commissioner of Patents